DIESEL LOCOMOTIVE OPERATING MANUAL NO. 2318

GP 9

for

MODEL GP9

With Vapor Car Steam Generator

JANUARY, 1954

ELECTRO-MOTIVE DIVISION
GENERAL MOTORS CORPORATION
LA GRANGE, ILLINOIS, U.S.A.

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INTRODUCTION

The purpose of this manual is to serve as a guide for railroad personnel engaged in the operation of the ELECTRO-MOTIVE 1750 HP GP9 locomotive.

The first three sections of the manual present the necessary information to enable the engineman to successfully operate the locomotive "over the road." A general description and location of the component parts is contained in Section 1. Section 2 outlines the recommended procedures to be followed for successful operation of the locomotive equipment. A description and general operation of the most commonly used "extras," including dynamic brakes, is found at the end of Section 2. Section 3 outlines the possible causes, location, and correction of difficulties that may be encountered while "on the road."

Sections 4 and 5 of the manual have been included for those who desire a more thorough knowledge of the locomotive's Systems and Electrical equipment. Charts and wiring diagrams are used to illustrate the descriptive material.

Section 6, Steam Generator, covers the operation and troubleshooting procedures to be followed if the locomotive is equipped with a Vapor Heating Corporation OK series steam generator.

Principal articles of each section are numbered consecutively for ready reference, as is each page of the section. Articles and pages are numbered in the 100 series type of numbering. A page in the 400's is in Section 4 as is any article numbered in the 400's.

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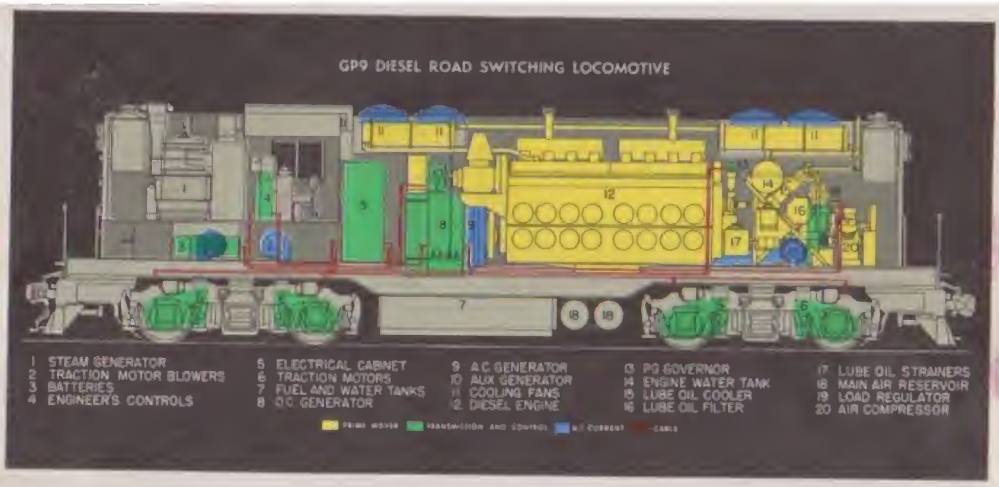


General Arrangement
Fig. 1-1

SECTION 1

DESCRIPTION

GENERAL DESCRIPTION

A description and general location of equipment on the GP9 locomotive is given in this section.

A locomotive consists of one or more units rated at 1750 horsepower per unit. In multiple unit operation, the locomotive is operated and controlled from the engineman's control stand in the lead unit.

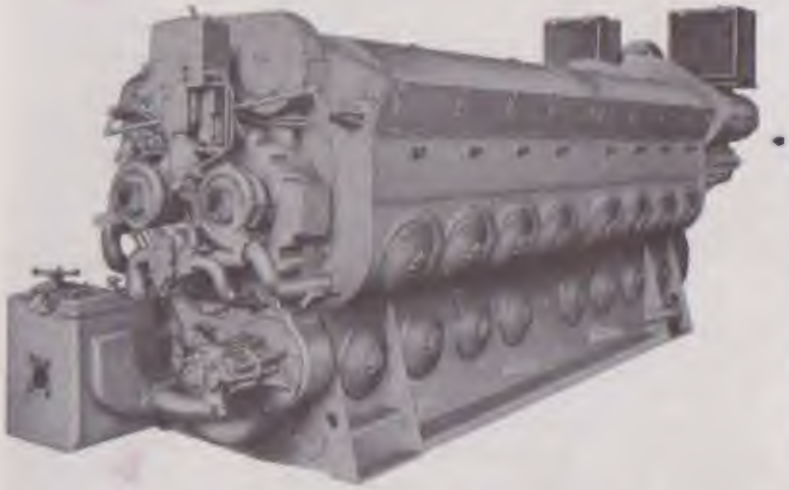
Basically, the short hood end of the GP9 is the front end of the unit and the long hood end is the rear end of the unit. In multiple unit operation, the units can be coupled together from either end.

Two types of brake equipment are used. To differentiate between the two types, the model designations "GP9L" and "GP9R" are used. The GP9L is equipped with 6BL brake equipment while the GP9R is equipped with 24RL brake equipment.

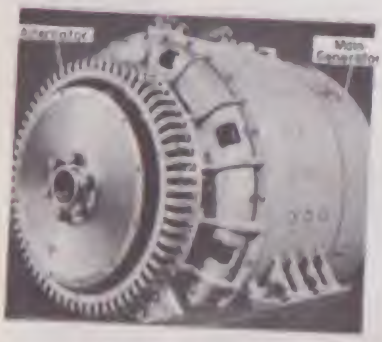
100 **Diesel Engine** The main generator and auxiliaries of these units are driven by a 16-cylinder V-type, 2 cycle, 1750 HP Model 567C Diesel engine, Fig. 1-2. The cylinders have an 8-1/2" bore and a 10" stroke. The two banks of the engine are arranged with respect to each other at an angle of 45°. The engine has a fully scavenging air system and has two blowers for this purpose. The blowers are mounted on the rear end of the engine; each blower is equipped with a separate air filter.

The engine is started by temporarily using the direct coupled main generator as a starting motor. Current from a storage battery "motors" the main generator to rotate the engine.

NOTE: In this manual, the word "engine" refers specifically to the Diesel engine; the word "locomotive" refers to a consist of one or more units.



Front Three-Quarter View 567C Engine
Fig. 1-2



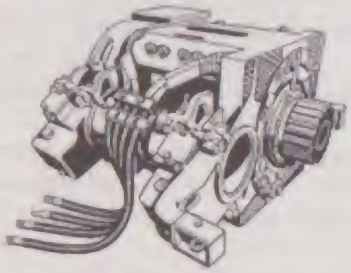
Main Generator and Alternator
Fig. 1-3

101 Main Generator

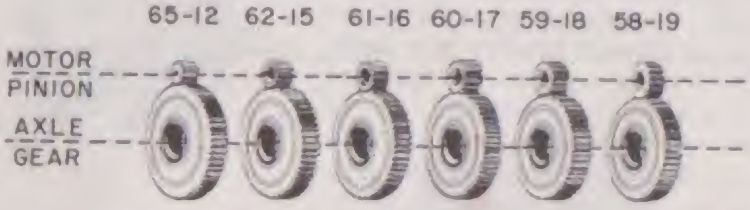
The main generator and alternator assembly Fig. 1-3, is connected to the Diesel engine crankshaft through a serrated coupling. The constant KW main generator produces direct current at a nominal 600 volts for operation of the traction motors. The armature of the main generator acts as the engine flywheel.

102 **Alternator** The alternator, Fig. 1-3, built into the engine end of the main generator frame, is a three phase alternating current generator. The alternating current (AC) produced is used to drive the four engine water cooling fans and four traction motor blowers.

103 **Traction Motors** Four Model D37 traction motors, Fig. 1-4, are used in each unit, mounted one on each axle. Each motor is geared to the axle, which it drives, by a motor pinion gear meshing with an axle gear. The ratio between the two gears, Fig. 1-5, is expressed as a double number such as 62/15. In this case the axle gear has 62 teeth while the pinion has 15 teeth.



Traction Motor
Fig. 1-4



Gear Ratio Chart
Fig. 1-5

During acceleration, the traction motor electrical hookup is changed to utilize the full power developed by the main generator, within the range of its current and voltage limits. The changes in the traction motor electrical connections is called transition. Four steps of transition are used on the GP9 as follows:

1. Series-Parallel
2. Series-Parallel Shunt
3. Parallel
4. Parallel-Shunt

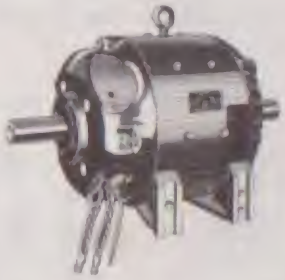
The changing of the traction motor electrical connections or transition is completely automatic during locomotive acceleration or deceleration on GP9 locomotives. There is no provision for effecting manual transition on a GP9 locomotive or for forestalling the automatic transition.

AUXILIARY EQUIPMENT

104 **Storage Battery** Power from a 32 cell 64 volt storage battery is used to start the Diesel engine. The storage battery compartment is accessible through hinged door sections in the "raised pattern" walk adjacent to the cab on each side of the short hood end of the unit. With the Diesel engine running, the auxiliary generator charges the storage battery.

105 **Auxiliary Generator**

A 10 KW auxiliary generator, Fig. 1-6, is driven directly from the rear gear train of the engine through flexible couplings. If the locomotive is equipped with a steam generator, an 18 KW auxiliary generator is used. The auxiliary generator produces direct current at 74 volts to charge the storage battery and supply the low voltage circuits for lighting, control, main generator battery field excitation and fuel pump operation.



Auxiliary Generator
Fig. 1-6

106 **Traction Motor Blowers** The GP9 is equipped with four alternating current driven traction motor blower motors, Fig. 1-7. Each motor has a fan, or blower wheel, mounted on its rotor shaft and supplies cooling air to one traction motor. The speed of the blower motor varies in proportion to the speed of the Diesel engine.

Traction Motor Blower
Fig. 1-7

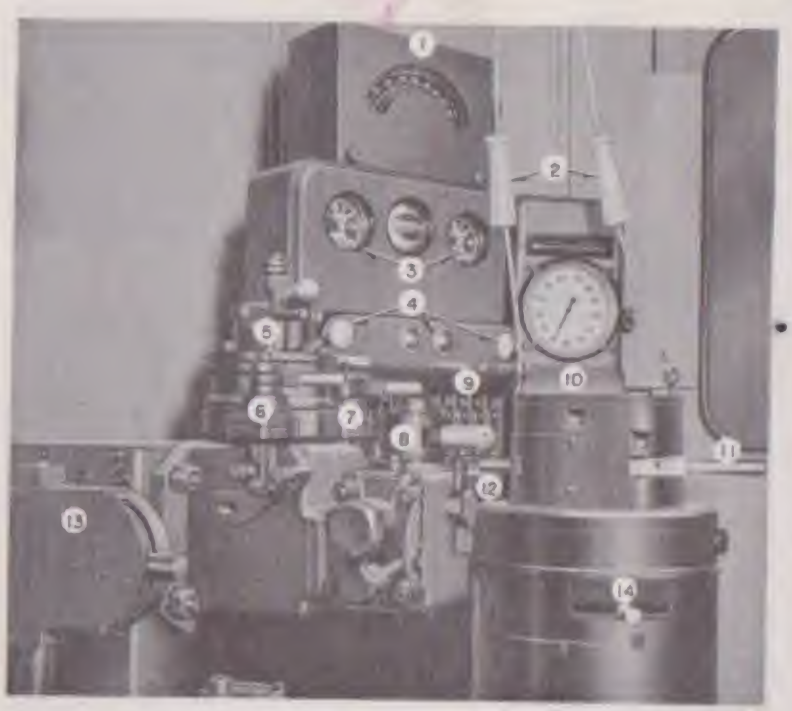
Radiator Cooling Fan
Fig. 1-8

107 **Radiator Cooling Fans** Four alternating current driven cooling fan motors, Fig. 1-8, are mounted in the roof of the long hood end of the locomotive above the engine cooling water radiator sections. A fan mounted on each rotor shaft, draws air through the radiator removing heat from the engine cooling water. The speed of the cooling fan motor varies in proportion to the speed of the Diesel engine.

108 **Air Compressor**

A 3-cylinder, two stage air cooled air compressor, Fig. 1-9, is driven through a flexible coupling from the front end of the engine crankshaft. Basically, the GP9 is equipped with a Model WXO air compressor which has a rating of 234 CFM displacement at 835 RPM.

Air Compressor
Fig. 1-9



1. Load Indicator
2. Horn Pull Cords
3. Air Gauges
4. Alarm Lights
5. Automatic Brake Valve
6. Sander Valve
7. Bell Ringer Valve
8. Independent Brake Valve
9. Control Switches (Circuit Breakers)
10. Speed Recorder
11. Throttle Lever
12. Selector Lever (If Used)
13. Headlight Control — Dim And Bright
14. Reverse Lever

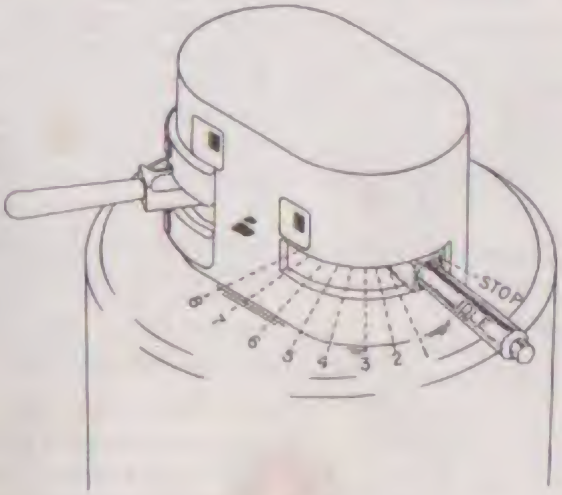
Engineman's Controls
Fig. 1-10

109 **Fuel Pump** The fuel pump is driven by a separate direct current electric motor through a flexible coupling. The pump assembly is mounted on the equipment rack which supports the engine cooling water tank. To operate the fuel pump, the 30 ampere "Fuel Pump" circuit breaker in the electrical cabinet must be "ON" and the "Control and Fuel Pump" circuit breaker on the engineman's control panel must be "ON."

OPERATING CONTROLS

Three levers and two brake valve handles control the entire operation of the locomotive. These are the throttle, reverse and selector levers, mounted in the controller, and the independent and automatic brake valve handles. See Fig. 1-10.

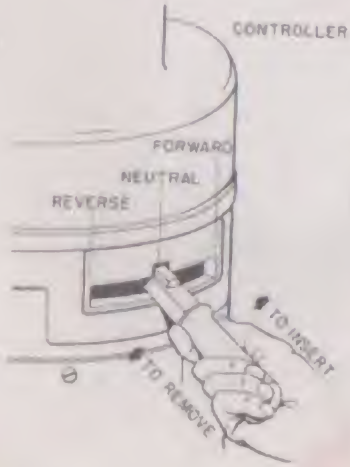
110 **Throttle Lever** This lever controls the speed of the Diesel engines in normal operation, Fig. 1-11. The position of the throttle is shown in the illu-



Throttle Lever Position
Fig. 1-11

minated indicator above the lever. The throttle has ten positions, Stop, Idle and running speeds 1 to 8. Stop can be obtained by depressing the emergency stop button on the end of the throttle lever and pushing the throttle lever one step beyond idle position; this stops all engines. Idle position is as far forward as the throttle lever can be moved without depressing the emergency stop button. Each running notch on the throttle increases the engine speed in 80 RPM increments from 275 RPM at idle and Run 1, to 835 RPM at full throttle. The throttle may be closed completely with one motion in an emergency, but should be closed one notch at a time in normal operation. It may be opened as rapidly as desired PROVIDING OPERATING CONDITIONS AND TRAIN CONSIST PERMITS. This arrangement is of special value in "kicking" cars and while operating over the road on a "tight" schedule.

111 **Reverse Lever** has three positions: The reverse lever, Fig. 1-12 FORWARD, NEUTRAL and REVERSE. Direction in which the locomotive moves is controlled by movement of this lever to the forward or reverse position. With reverse lever in neutral, no power will be developed if the throttle is opened, even though the engine speed will increase. The reverse lever should be moved ONLY when locomotive is standing still.



Reverse Lever Positions
Fig. 1-12

The reverse lever can be removed from the control stand only when the lever is in the neutral position, the throttle is in "Idle", and the selector

lever is in "Off." Removal of the reverse lever locks the operating controls in the controller. Remove the reverse lever from all non-operating control stands.

112 **Selector Lever** All GP9 locomotives are basically equipped with automatic transition. Transition is FULLY AUTOMATIC, both forward and backward, and no provision is made basically for making transition manually. However, a selector lever is applied to all GP9 locomotives equipped with 24 RL brake equipment. The selector lever is applied to GP9 locomotives having 6 BL brake equipment only when the locomotive is equipped with dynamic brakes or for special multiple unit operations. The selector lever is used to control dynamic brake operation and/or to effect manual transition on any units coupled to the GP9 locomotive not equipped with automatic transition. An interlock in the controller prevents the throttle from being opened unless the selector lever is in either the Off or No. 1 position.

On locomotives equipped with dynamic brakes moving the selector lever to the "Off" position does not establish any portion of the braking circuit. Moving the lever to the "B" position partially establishes the braking circuit. Moving the lever farther, to the right of "B," completes the circuit and increases the braking effort (See Art. 229 for dynamic brake operation).

113 **Mechanical Interlocks on the Controller** The levers on the control stand are interlocked so that:

1. The reverse lever can be operated only with the selector lever in either "No. 1" or "OFF" position and the throttle at "IDLE."
2. The reverse lever can be removed from the control stand only with the selector lever in "OFF" and the throttle at "IDLE." Removing the reverse lever locks the throttle and selector levers.

3. Selector lever can be moved between "OFF" and "No. 1" only when the throttle is in "IDLE" or "STOP."
4. Throttle lever cannot be advanced with selector lever in "OFF" or "B" position.
5. Selector lever can be moved to "B" position only with the throttle in "IDLE" and the reverse lever in Forward or Reverse.
6. Throttle can be moved to "STOP" with reverse and selector levers in any position.
7. Throttle lever in "STOP" locks against movement of the reverse lever, but the selector lever may be moved to any position if reverse lever is in Forward or Reverse.

NOTE: When using the selector lever to effect manual transition from 2 to 3 and 3 to 2 on older type units, the throttle should be reduced to Run 6 before moving the selector lever to the desired position.

AIR BRAKE EQUIPMENT

GP9L locomotives are equipped with the 6BL brake equipment, Fig. 1-13. GP9R locomotives are equipped with the 24RL brake equipment, Fig. 1-14. No detailed information of the operation of the 6BL or 24RL brake equipment is given as all engineman are more or less familiar with the operation of this type of equipment.

The air brake gauges are located on the engineman's control panel. In general, the cab air brake equipment consists of the automatic brake valve, independent brake valve, Rotair Valve (24RL only), Brake Valve Cut-out Cock or Double-heading Cock, Transfer Valve or Three Position Double-heading Cock (6BL only), Feed Valve, and Safety Control Cut-out Cock (24RL only).

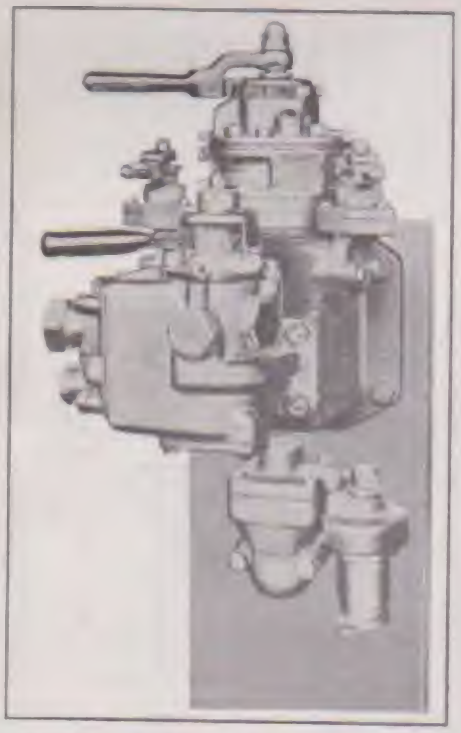


Fig. 1-13 — 6BL Brake

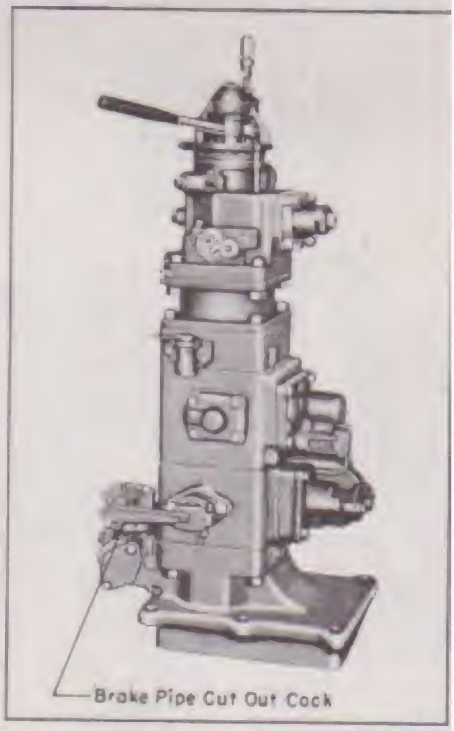
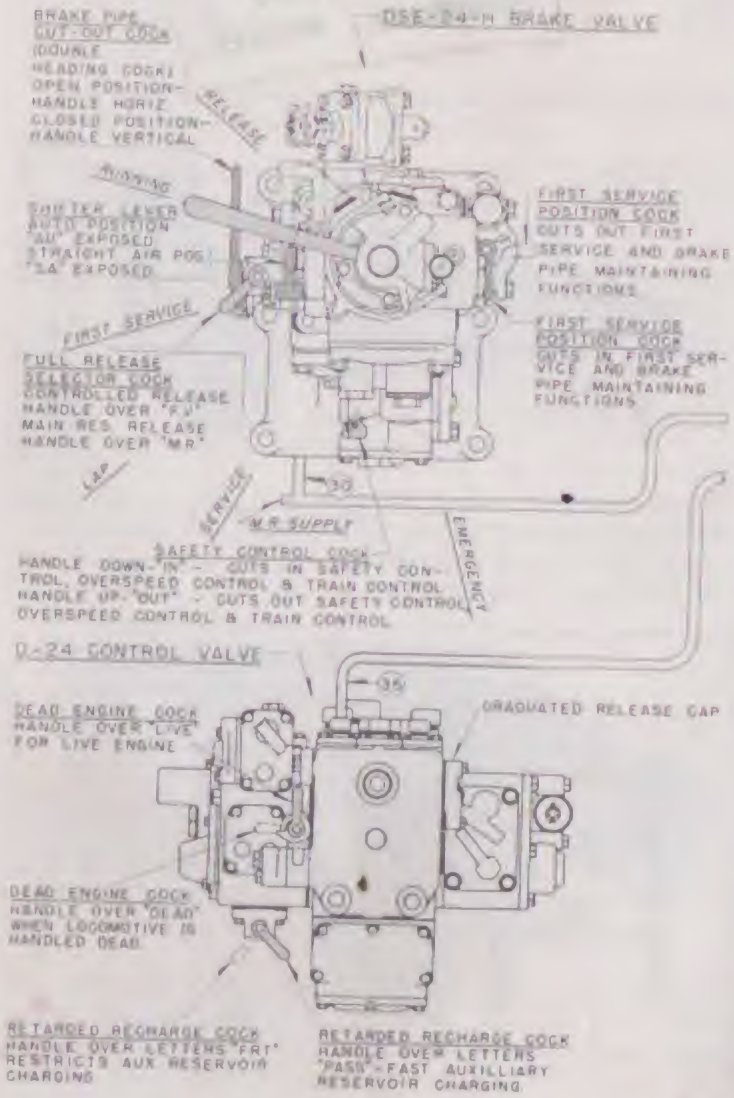
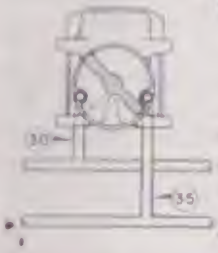


Fig. 1-14 — 24RL Brake


BRAKE PIPE CUT-OUT COCK (DOUBLE HEADING COCK) OPEN POSITION- HANDLE HORIZ. CLOSED POSITION- HANDLE VERTICAL
DSE-24-H BRAKE VALVE
RELEASE
RUNNING
SHUTTER LEVER AUTO POSITION "AU" EXPOSED STRAIGHT AIR POS. "SA" EXPOSED
FIRST SERVICE
FIRST SERVICE POSITION COCK CUTS OUT FIRST SERVICE AND BRAKE PIPE MAINTAINING FUNCTIONS
FIRST SERVICE POSITION COCK CUTS IN FIRST SERVICE AND BRAKE PIPE MAINTAINING FUNCTIONS
FULL RELEASE SELECTOR COCK CONTROLLED RELEASE HANDLE OVER "FU" MAIN RES. RELEASE HANDLE OVER "MR"
LAP
SERVICE
30
M.R. SUPPLY
EMERGENCY
SAFETY CONTROL COCK HANDLE DOWN "IN" - CUTS IN SAFETY CONTROL, OVERSPEED CONTROL & TRAIN CONTROL HANDLE UP "OUT" - CUTS OUT SAFETY CONTROL OVERSPEED CONTROL & TRAIN CONTROL
D-24 CONTROL VALVE
35
GRADUATED RELEASE CAP
DEAD ENGINE COCK HANDLE OVER "LIVE" FOR LIVE ENGINE
DEAD ENGINE COCK HANDLE OVER "DEAD" WHEN LOCOMOTIVE IS HANDLED DEAD
RETARDED RECHARGE COCK HANDLE OVER LETTERS "FRT" RESTRICTS AUX RESERVOIR CHARGING
RETARDED RECHARGE COCK HANDLE OVER LETTERS "PASS" - FAST AUXILLIARY RESERVOIR CHARGING

K-2-A ROTAIR VALVE



HANDLE OVER LETTERS "FRGT"
CUTS IN CONTROLLED EMERGENCY FEATURE, SPLIT SERVICE REDUCTION, & INDEPENDENT BRAKE VALVE

HANDLE OVER LETTERS "FRGT LAP" #
CUTS OUT INDEPENDENT BRAKE VALVE CONTROLLED EMERGENCY STILL IN EFFECT

HANDLE OVER LETTERS "PASS LAP" #
CUTS OUT CONTROLLED EMERGENCY & THE INDEPENDENT BRAKE VALVE

HANDLE OVER LETTERS "PASS"
ALL FEATURES REMAIN CUTOUT AS IN "PASS LAP" EXCEPT INDEPENDENT BRAKE VALVE IS CUT IN

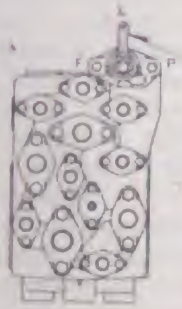
POSITION USED FOR TRAILING "A" UNITS

TO INDEPENDENT BRAKE VALVE

"B" UNIT CONTROL VALVE SECTION

NOTE: WHEN DOUBLE HEADING, THE ROTAIR VALVE ON THE SECOND OPERATING UNIT SHOULD BE LEFT IN A LIVE POSITION, "FRGT" OR "PASS", TO RETAIN USE OF INDEPENDENT BRAKE VALVE

WHEN OPERATING A "B" UNIT ALONE WITH THE HOSTLER'S CONTROL, THE CONTROLLED EMERGENCY SELECTOR COCK MUST BE PLACED IN "PASS" POSITION TO EFFECT QUICK ACTING EMERGENCY IF NEEDED



HANDLE OVER "F"
CUTS IN CONTROLLED-EMERGENCY BRAKE CYLINDER PRESSURE DEVELOPMENT FEATURE

HANDLE OVER "L"
POSITION NOT USED WITH OUR EQUIPMENT HANDLE MUST BE IN PASSENGER OR FREIGHT POSITION

HANDLE OVER "P"
CUTS OUT CONTROLLED-EMERGENCY BRAKE CYLINDER PRESSURE DEVELOPMENT FEATURE

VIEW OF PIPE BRACKET FOR CONTROL VALVES
SHOWING CONTROLLED-EMERGENCY CUT-OUT COCK IN "B" UNITS

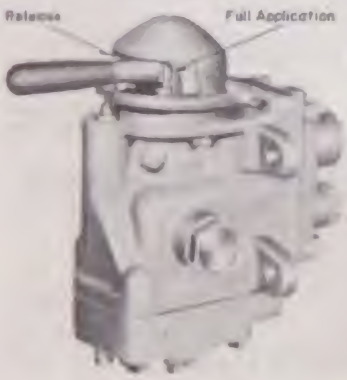
24 RL Brake Cock Handle Positions
All Types Of Service

114 **Automatic Brake Valve** The automatic brake valve handle has six positions: Release, Running, Holding (6BL) or First Service (24RL), Lap, Service and Emergency.

In multiple unit operation, with 6BL brake equipment, the automatic brake valve handle in all trailing units MUST be kept in the Lap position. If the brake valve handle is removable, it must be removed from the brake stand in the Lap position in the trailing units.

The automatic brake valve handle (rigid or hinged handle) of the 24RL brake equipment is removable in the running position. In multiple unit operation, this brake valve handle should be removed in Running position from all non-operating control stands.

115 **Independent Brake Valve** The independent brake valve handle, Fig. 1-15, has two positions, release and full application, with the application zone between the two positions. The brake valve is of the self-lapping type which automatically laps off the flow of air and maintains brake cylinder pressure when the application pressure reaches the value corresponding to the position of the brake valve handle in the application zone. Locomotive brakes may be released after automatic application by depressing the independent brake valve handle in release position.



Independent Brake Valve
Fig. 1-15

In multiple unit operation, the independent brake valve handle in all trailing units must be kept in the "Release" position.

If the brake valve handle is removable, remove handle from brake valve in "Release" position.

116 **Rotair Valve**

The K2A rotair valve, Fig. 1-16, used with the 24RL brake equipment, is a selector valve with four positions: "Freight," "Freight Lap," "Passenger," and "Passenger Lap."

K2A Rotair Valve
Fig. 1-16

The rotair valve is used to "cut in" the features which control the rate of locomotive brake cylinder pressure buildup. With long freight trains, the handle is placed in the "Freight" position in the lead unit. In an emergency application, with the handle in "Freight," a controlled buildup of brake cylinder pressure is obtained. With passenger trains, short freight trains, and when handling light locomotives, the handle is placed in "Passenger" position in the lead unit. In an emergency application, with handle in "Passenger," a rapid buildup of brake cylinder pressure is obtained.

During a safety control application (foot taken off the "Deadman" pedal, locomotive overspeed or failure to acknowledge a train control signal) a split reduction of brake pipe pressure is obtained with rotair valve in "Freight" and a full service reduction of brake pipe pressure is obtained with rotair valve in "Passenger" position.

In multiple unit operation, in all trailing units, place handle in "Passenger Lap" if lead unit is set for "Passenger", and in "Freight Lap" if lead unit is set for

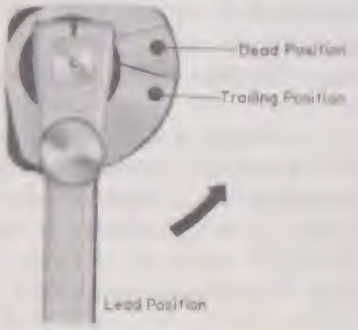
"Freight". In either "Lap" position the controlled emergency feature is under control of the engineman operating the brakes from the lead unit. The "Lap" position of the rotair valve also cuts out the independent brake valves in all trailing units, obtaining full control over the locomotive brakes from the lead unit.

117 Brake Pipe Cut-out Cock (Double-heading Cock)

The brake pipe cut-out cock or double-heading cock of the 24RL brake equipment, Fig. 1-14, is a two position cut-out cock. The handle is spring loaded and self locking. To move handle, pull handle outward if horizontal, or upward if vertical, and then rotate to the desired position. With the handle in a horizontal position, the brake pipe is "cut in." With the handle in a vertical position, the brake pipe is "cut out."

The brake pipe cut-out cock or double-heading cock used with the 6BL brake equipment is a three position double-heading cock. The positions of the double-heading cock handle, Fig. 1-17 are: "Lead," "Trailing" and "Dead." A spring loaded pin extends from the handle and engages locking holes drilled in the valve body at the "Trailing" and "Dead" positions. To move the handle out of either of these positions, the pin must first be pulled "out" and the handle then rotated to desired position.

In multiple unit operation, the double-heading cock in all trailing units is placed in the "Trailing" position. When locomotive is being hauled Dead in a train or is operated in double-heading service, place double-heading cock in the "Dead" position.



Brake Pipe Cut-Out Cock
Or Double-Heading Cock
Fig. 1-17

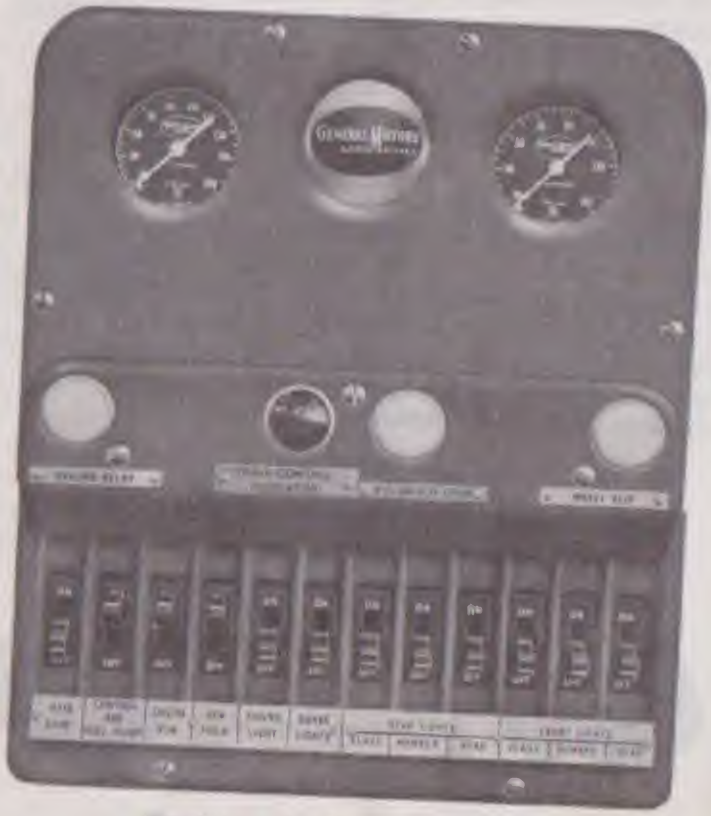
118 **Safety Control Foot Pedal** The safety control foot pedal (if used) is located in front of the engineman's seat. On locomotives equipped with the 24RL brake valve, having the hinged automatic brake valve handle, the handle provides an alternate control when it is depressed sufficiently to just contact the sanding bail. Either the pedal or the automatic brake valve handle must be kept depressed at all times except when the locomotive is stopped and the locomotive brakes are applied (30 pounds or more brake cylinder pressure). If both the foot pedal and the automatic brake valve are released, a penalty application of the brakes will result.

ENGINEMAN'S CONTROL PANEL

119 Load Indicating Meter This meter, Fig. 1-18, is an accurate guide to the load and pulling force of the locomotive. The meter is connected into the leads of the No. 2 motor. Since the amperage is the same in all motors, each motor receives the amount of current shown on the meter. The dial of the meter is graduated into amperes from 0 at the left to 1500 amperes at the extreme right of the scale.

Load Indicating Meter
Fig. 1-18

120 **Operating Circuit Breakers** The engineman's control panel is shown in Fig. 1-19. An identifying nameplate is located below each circuit breaker type switch. To start the Diesel engine and control its speed from the throttle, the "Control and Fuel Pump" and "Engine Run" circuit breakers must be "ON." To move the locomotive the "Generator Field" circuit breaker must also be "ON." The "Automatic Sanding" feature is cut in with the "Automatic Sanding" circuit breaker in the "ON" position.



Engineman's Control Panel
Fig. 1-19

121 **Wheel Slip Light** "Flashing" of the wheel slip light located on the engineman's control panel, Fig. 1-19, during power operation, indicates the wheels are slipping. With the "Automatic Sanding" feature cut in (Automatic Sanding circuit breaker in "ON" position) the wheel slip will generally be corrected immediately through the locomotive wheel slip control system and the light will go out. The throttle should be reduced ONLY if continuous wheel slip occurs.

122 **Ground Relay Light** The ground relay light on the engineman's control panel, Fig. 1-19, when lit indicates a tripped ground relay located in the electrical cabinet. With the ground relay light ON, the alarm bell will ring, and the engine speed will be reduced to Idle. (The engine will stop if the Ground Relay tripped with the throttle in the 5th or 6th notch).

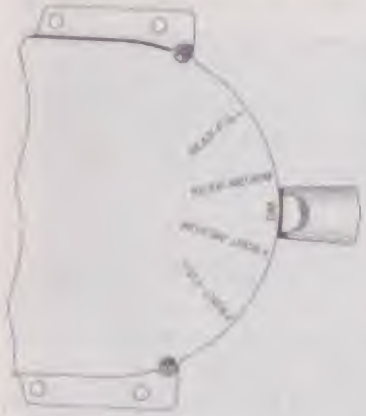
123 **"PC" Switch and Light** The PC, or pneumatic control, switch is often called the power cutoff switch. This is a normally closed electric switch that is operated by the air brake system. During a safety control or emergency air brake application this switch opens and automatically reduces the power output of the locomotive. When tripped open the PC switch immediately reduces the speed of all engines to Idle. If the throttle is left in the fifth or sixth notch when the PC switch is tripped, the engines will stop. A white "PC Switch Open" indicating light, mounted on the engineman's control panel, will be lit whenever the PC switch is tripped, Fig. 1-19.

The PC switch automatically resets itself provided that (1) the throttle is returned to IDLE, and (2) control of the brake is recovered (see Section 3 for method of recovering control of the brake).

124 **Headlight Control Switch** The twin sealed beam front and rear headlights are controlled by the

front and rear headlight circuit breakers on the engineman's control panel, Fig. 1-19. A dimming switch, Fig. 1-20, is mounted on one side of the air brake equipment stand.

On GP9 locomotives equipped for multiple unit operation, a remote headlight control switch, Fig. 1-21, is enclosed in a box mounted just below the engineman's front window. This remote headlight control switch allows the engineer to control the operation of the headlight of the rear unit from the lead unit. The switch has four positions and is set as follows:



Headlight Dimming Switch
Fig. 1-20

Remote Headlight Switch
Fig. 1-21

1. In single unit operation, the switch is placed vertical with the arrow pointing up to "Single Unit."

2. In multiple unit operation, the switch in the LEAD unit is placed horizontal with the arrow pointing to "Controlling - with unit coupled at No. 2 end" if the trailing units are coupled to the long hood end of the lead unit.

3. If the trailing units are coupled to the short hood end of the Lead Unit, then the control switch is placed vertical with the arrow pointing down to "Controlling - with unit coupled at No. 1 end."

4. In the last unit of the locomotive consist, the headlight control switch is placed horizontal with arrow pointing to "Controlled" position.

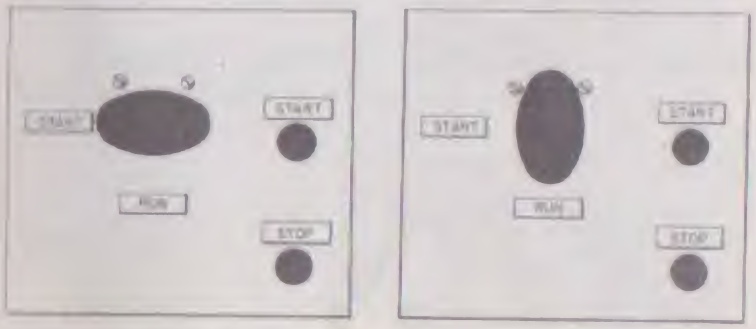
NOTE: When more than two units are coupled together, the headlight control switch in all units, coupled between the lead unit and last unit of the consist, MUST be placed vertical with the arrow pointing up to "Single unit or intermediate units."

125 **Air Brake Gauges** These are standard gauges mounted on the engineman's control panel. Each gauge is clearly labeled as to its function.

ELECTRICAL CONTROL CABINET

The electrical control cabinet contains the various contactors, relays and other equipment necessary for the electrical and electro-pneumatic control of the unit. It forms the rear wall of the cab and is accessible from both the cab and engine room sides.

126 **Isolation Switch** This switch has two positions, START (handle horizontal) and RUN (handle vertical), Fig. 1-22. In START position, the power plant is isolated (off the line) from the control circuit, and the



Isolation Switch - Start and Run Positions
Fig. 1-22

engine speed is reduced to idle. The engine will remain at idle speed and will not respond to throttle control. The power contactors in the electrical control cabinet will not operate when control levers are normal. The "Alternator Failure" light and alarm bell is inoperative.

Engine START and STOP buttons are effective only with the isolation switch in the START position.

The isolation switch must be in the RUN position for the unit to develop power. The isolation switch should be moved only with the engine at idle speed or stopped. Use the manual layshaft lever to bring the engine to idle or stop when the locomotive is under power or in dynamic braking. If the isolation switch is in the START position, do not place it in RUN while operating in dynamic braking.

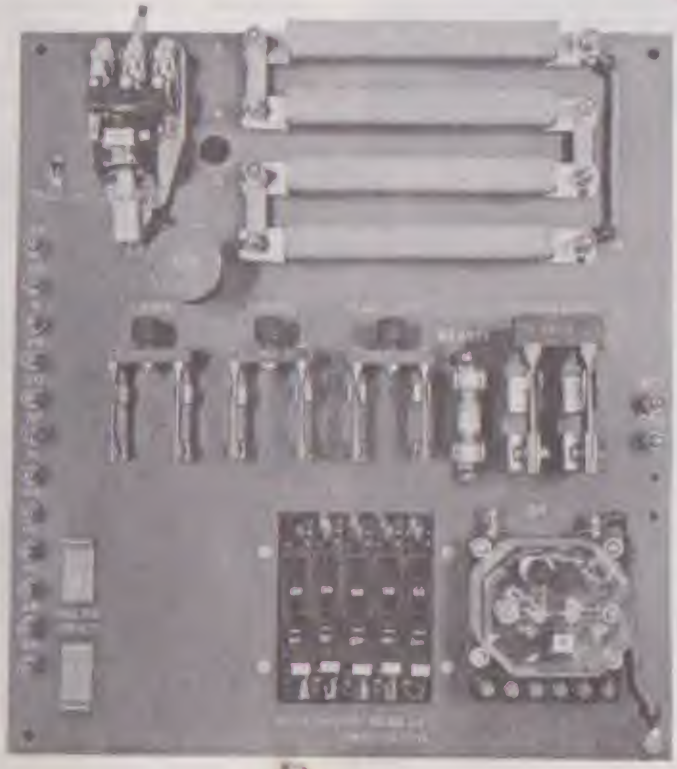
127 **Engine Start and Stop Buttons** The engine start and stop buttons, Fig. 1-22, located in the electrical control cabinet, are operative only with the isolation switch in the START position. When starting the Diesel engine, press START button in firmly and hold until engine starts (not more than fifteen seconds). To normally stop engine, press STOP button in firmly and hold in until engine stops.

128 **Fuses-Knife Switches and Circuit Breakers** Located in the cab side of the electrical control cabinet, Figs. 1-23 and 1-24, are the following fuses, knife switches and circuit breakers:

(a) 80 Amp. Battery Field Fuse
(b) 150 or 250 Amp. Auxiliary Generator (Battery Charging) Fuse
(c) 400 Amp. Starting Fuse
(d) 60 Amp. Automatic Train Control Fuse
(e) Automatic Train Control (ATC) Switch

Battery Switch Panel
Fig. 1-23

(f) Main Battery Switch
(g) Main "Lights" Switch
(h) Main "Control" Switch
(i) Auxiliary Generator Switch
(j) Ground Relay Knife Switch
(k) Circuit Breakers: Heaters, Lights, Fuel Pump, Auxiliary Generator Field and Alternator Field



Distribution Panel
Fig. 1-24

For proper locomotive operation, all fuses must be good and securely in place, all knife switches should be closed and the above circuit breakers should be in the ON position in all units of the locomotive consist.

Ground Relay
Fig. 1-25

129 Ground Relay

The ground relay, Fig. 1-25, is located in the electrical control cabinet. With a tripped ground relay, the power output of the unit is automatically stopped, the engine speed is reduced to idle and the white ground relay light will be ON (only in the unit affected). If the Ground Relay tripped while the throttle was in the 5th or 6th notch, the engine would stop. The alarm bells will ring in all units. To reset the ground relay "push in" relay reset button or remote reset button that extends through cabinet door. ALWAYS place ISOLATION SWITCH in START before resetting ground relay.

Fig. 1-26

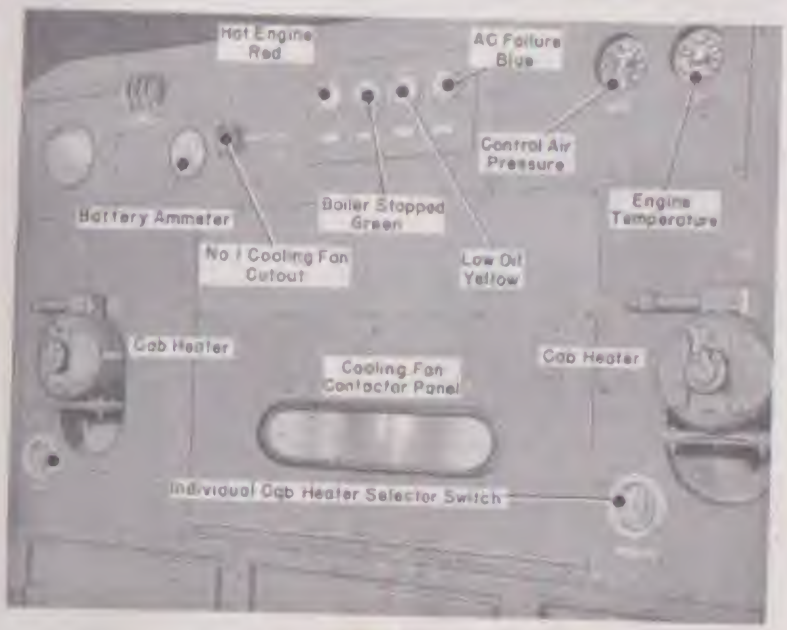
130 Control Air Pressure Regulator

The "control air," for operating power contactors, reverser and cam-switches, is supplied from the main reservoir and reduced to 90 ± 3 pounds by the control air pressure regulator. The regulator, Fig. 1-26, is located in the cab side of the electrical cabinet. A bolt and locknut on top of the regulator provides means of adjustment. A control air pressure gauge, with a

name-plate "ELECTRIC AIR PRESSURE," is mounted on the rear wall of the cab. For proper locomotive operation this gauge should read 90 ± 3 pounds.

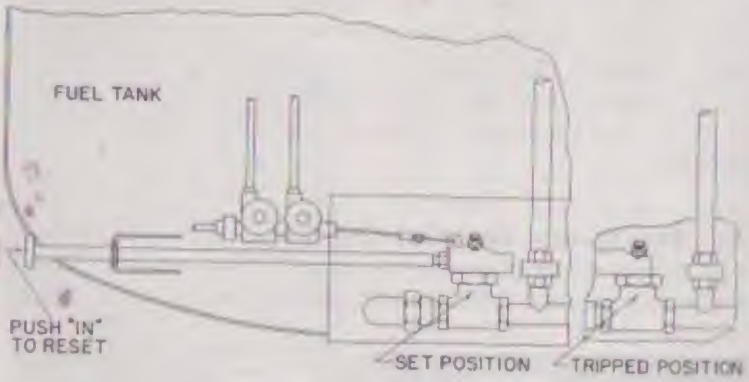
131 **Alarm Indications** Fig. 1-27. Four signal lights are mounted on the rear wall of the cab. An alarm bell is mounted on the engineroom side of electrical cabinet. The signal lights indicate a hot engine, steam boiler stopped, low oil pressure and an alternator failure (no AC power). In case of an alarm, the bell will ring in all units, but the signal light will be ON only in the unit affected.

132 **Emergency Fuel Cut-Off Ring** An emergency fuel cut-off pull ring is mounted on one side of the electrical cabinet. Two additional pull rings are located



Rear Wall Operating Cab
Fig. 1-27

one on each side of the locomotive above the front end of the fuel tank. Pulling one of the three emergency pull rings will trip the emergency fuel cut-off valve, stopping the fuel supply to the fuel pump. The valve is located in a closed compartment at the lower front center of the fuel tank. To reset: Push control rod IN, Fig. 1-28.



Emergency Fuel Cutoff
Fig. 1-28

ENGINE ROOM

The two ends of the engine are designated FRONT and REAR as shown in Fig. 1-29, which will serve to identify the cylinder locations, ends and sides of the engine, as they are referred to in this manual. The governor, water pumps, and lubricating oil pumps are on the FRONT END. The blowers, oil separator and the generator are mounted on the REAR END.

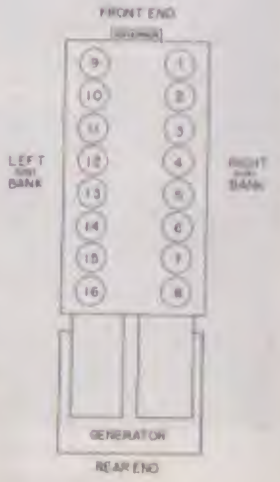


Fig. 1-29

The engine is placed [illegible] its rear end is toward th[illegible]

end of the unit when the unit is operating in its normally forward direction.

133 **Engine Governor** The governor, Fig. 1-30, on the front end of the engine, performs the function of controlling the speed of the Diesel engine, as directed by the position of the throttle at the control stand. The speed of the engine is controlled from 275 RPM at Idle to 835 RPM in Run 8. The "orders" of the throttle are transmitted to the electro-hydraulic governor through electrical circuits. The governor is connected through a linkage to the injector control shafts on each bank of the engine. By regulating the position of the injector racks, and consequently the fuel injected to each cylinder, the speed of the engine is controlled. The governor performs its job of seeing that the engine rotates at the speed ordered by the throttle, regardless of how much or how little fuel is needed.

A device called the load regulator, acts to cause the governor to allow injection of no more or no less fuel to each cylinder than that which will result in a predetermined power output for each throttle position.

A low oil pressure device built into the governor protects the engine in case of low oil pressure or high vacuum on the suction side of the pressure lubricating oil pump. In the event of such lubricating oil trouble, the governor will immediately

Engine Governor
Fig. 1-30

stop the engine and light the yellow low oil alarm signal in the unit affected. The alarm bell will ring in all units. When the engine stops, the "Blue" Alternator Failure Light will also be ON in the unit affected.

When the governor low oil pressure device stops the engine, a push button protrudes from the front of the governor housing and exposes a red band around the shaft of button. This push button must be pressed IN and the Isolation Switch moved to START position to turn off alarm bell. The low oil button will not trip if the engine is stopped by any means other than oil trouble.

If an engine is stopped by the governor low oil device, the push button must be reset before the engine can again be started. When the engine is started and run at idling speed, the governor will again stop the engine after approximately forty seconds, if the condition remains which caused the original shutdown. The engine should not be repeatedly started if the governor persists in shutting the engine down. If an attempt is made to run the engine above idling speed during the delay period, the governor will immediately stop the engine if the oil pressure and suction are not normal.

Load Regulator
Fig. 1-31

134 Load Regulator

The Load Regulator, Fig. 1-31, is located adjacent to the air compressor on the right side of the unit. The primary purpose of the load regulator is to automatically control the loading of the engine by the main generator so that a predetermined power output is obtained for each position of the throttle. The load regulator is an automatically operated

Engine Overspeed Trip
Fig. 1-32

rheostat connected in series with the main generator battery field. (The main generator battery field is a low voltage externally excited field.)

The Load Regulator is in minimum field when the brush arm, as viewed through the window, is in the four o'clock position. Maximum field is obtained with the brush arm in the eight o'clock position.

135 **Engine Overspeed Trip** This device is located at the front end of the engine and will trip to bring the engine to a stop, if the engine speed should exceed approximately 910 RPM. Once this overspeed device is tripped, it must be reset manually (by pulling the lever counter-clockwise until it latches) before the engine can again be started. See Fig. 1-32.

136 **Manual Layshaft Lever** The manual layshaft control lever is attached to the end of the injector control shaft at the left front corner of the engine, Fig. 1-33. This lever may be used to manually shut down the engine, or to bring the speed to idle (as when taking an engine 'off the line'). It is also used to facilitate the starting of a cold engine.

Manual Layshaft Lever
Fig. 1-33

MISCELLANEOUS EQUIPMENT

137 **Speed Recorder** The speed recorder, located in front of the control stand, is a hydraulically operated speed indicator with a speed recording tape and an odometer. It is driven from the number 2 axle of the unit, through a flexible cable.

Hand Brake
Fig. 1-34

138 **Hand Brake** The hand brake, Fig. 1-34, is mounted on the outside of the engineroom hood on the rear platform of the locomotive.

The hand brake is applied by pumping the long handle up and down, and is released by pulling on the short release lever. It is effective on one pair of wheels only.

Before moving the locomotive, be sure the hand brake is completely released.

139 **Manual Sanding Valve** When the locomotive is equipped with 24RL brake with the hinged automatic brake valve handle, sanding is accomplished by depressing the lever beyond the safety control position previously described. This movement operates the sanding bail which opens a port to supply air to the sanding equipment. On locomotives having a rigid handle on the 24RL automatic brake valve, an independent sanding

valve is installed. This valve is operated by moving the lever forward or backward until it latches. Locomotives equipped with 6BL brake equipment have a sanding valve mounted on the brake valve assembly. The sanding operating valve has three positions: Forward, OFF and Reverse, which allows application of sand for movement in either direction.

140 **Classification Lights** Four permanently fixed clear bull's-eye lenses are provided, two on the front of the short locomotive hood and two on the rear of the locomotive. Inside the hood and behind each bull's-eye, a small compartment contains the classification light bulb and colored lenses. Red and green lenses are provided in each compartment which can be moved into a position between the bulb and the bull's-eye. To accomplish this, a locking pin is removed, the desired lens swung into place and the locking pin replaced. The colored lenses are accessible from the inside of the hood through hinged doors in the compartments. When both red and green lenses are out of position the permanent bull's-eye lens will show a white light, thus making three colors available.

141 **Horn Valves** The horns are operated by air valves which are controlled by pull-cords, above the control stand. The horn shut-off valve is located behind the engineman's control panel adjacent to the short hood end compartment door.

142 **Bell Ringer** The locomotive signal bell is normally located behind the pilot on the right front end of the locomotive. It is operated by an air valve located at the engineman's station.

143 **Windshield Wipers** The windshield wipers, four in number, are controlled by valves over the cab windows, two on each side of the cab. The wipers

operate independently of each other. They should not be run on a dry window as dirt on the glass or blade will scratch the glass.

144 **Cab Heaters and Defrosters** Two cab heaters are mounted in the rear wall of the operating cab, above the electrical control panels, Fig. 1-27.

The No. 1 cooling fan cutout switch must be in "Off" position, and the manual shutter control levers (one on each side of the electrical cabinet) should normally be in the "Closed" position when operating the cab heaters.

Warm air is forced through ducts by the heater fans into the operating cab. Each fan motor is controlled individually by a four position switch mounted on the rear wall of the cab.

Hyatt Journal Box
Fig. 1-35

There are no individual defrosters used on the GP9 locomotive. When the cab heater motors are turned on, warm air blows onto the front and rear windows keeping them clear of condensation.

145 **Trucks** Two four-wheel flexible trucks are provided on each GP9 unit. The axles are all equipped with Hyatt roller bearing journal boxes. A stench bomb on each journal box will release a pungent odor if the temperature inside the journal box exceeds 220° F., Fig. 1-35.

SECTION 2

OPERATION

The successful and dependable operation of the locomotive is dependent upon the quality of inspection and repair at regular maintenance periods, as well as the proficiency of the operating crews. As a supplement to the regular terminal maintenance, a "pre-service check" should be made by the engine crew upon boarding the locomotive.

BASIC INFORMATION

200 When Boarding the Locomotive

A. Ground Inspection - Locomotive Exterior and Running Gear.

Check For:

1. Fuel oil, lube oil, water or air leaking from the locomotive.
2. Loose or dragging parts.
3. Proper positioning of angle cocks and shut off valves.
4. Observe brake cylinder piston travel, if air brakes are set.
5. Condition of brake shoes.
6. Drain condensate from #2 main reservoir.
7. Adequate fuel supply showing in fuel tank full length sight glass.
8. Proper connecti of air hoses and jumper cable (if used in multiple unit operation).

B. Engineroom Inspection - Long Hood End

(If Diesel engine is stopped see Arts. 201 and 202 for starting instructions).

With Diesel engine running, check:

1. Lubricating oil supply.
   a. Diesel engine
   b. Governor
2. Air compressor lube oil pressure gauge.
3. Diesel engine lube oil pressure gauge.
4. Fuel flow in fuel return sight glass.
5. Check for oil, water and fuel leaks.
6. Engine cooling water level in supply tank.
7. Drain condensate from #1 main reservoir sump tank.
8. Close air box drain valves.

C. Operating Cab Inspection

Check:

1. "Control and Fuel Pump" and "Engine Run" circuit breakers must be in "ON" position.
2. Place throttle lever in Idle, the reverse lever in neutral and selector lever in No. 1 position.
3. Check position of the automatic and independent brake valves. Apply locomotive brakes.
4. Brake pipe cutout cock should be "cut in."
5. Rotair valve (locomotive equipped with 24RL brake) should be in "Passenger" or "Freight" position depending upon the service required.
6. If engine is stopped, place isolation switch in START. See Arts. 201 and 202 for engine start-

ing instructions. If engine is running, place isolation switch in RUN.

7. Place "Headlight Control" switch in "Single Unit" position or proper "Controlling" position if operating in Multiple Unit.
8. Place unit selector switch in proper position if equipped with dynamic braking.
9. In the electrical cabinet, all fuses must be securely in place, all knife switches closed and circuit breakers should be in the "ON" position.
10. Check steam generator water supply at remote water level gauge.
11. If engine is running, check battery ammeter.

D. Trailing Cab Inspection (Multiple Unit Operation)

Check:

1. All circuit breakers at engineman's control station should be in OFF position.
2. Throttle lever should be in Idle, selector lever in OFF position, and reverse lever removed from the control stand.
3. Independent brake valve should be in Release position.
4. Automatic brake valve should be in Running position (locomotive equipped with 24RL brake) or in "LAP" position (locomotive equipped with 6BL brake).
5. Rotair valve (locomotive equipped with 24RL brake) should be in the proper LAP position.
6. Brake pipe cutout cock should be in "Trailing" (6BL) or "OUT" (24RL) position.
7. If engine is stopped, place isolation switch in Start. See Arts. 201 and 202 for engine starting

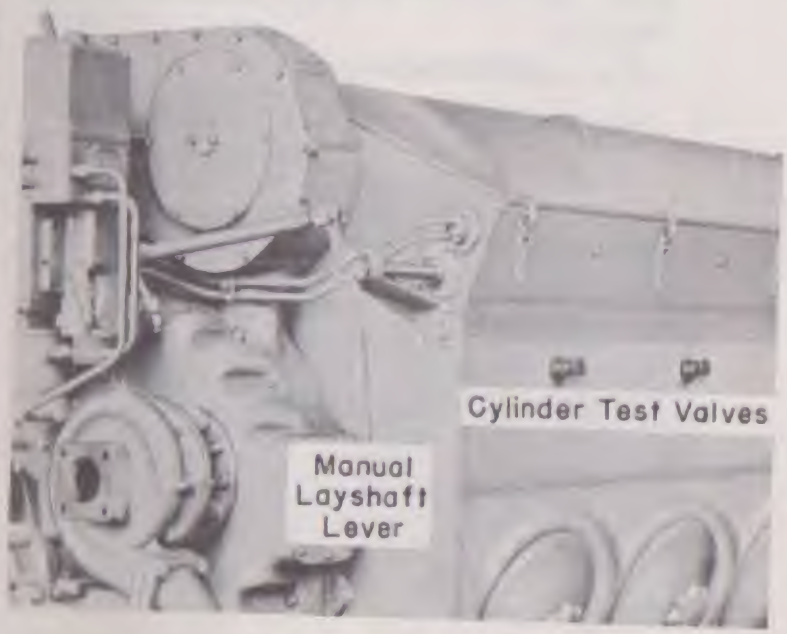
7. Reverse lever must be in Neutral.

8. At the engineman's control station, place the "Control and Fuel Pump" and "Engine Run" circuit breakers in the "ON" position.

NOTE: When operating the GP9 as a lead unit in multiple with older type units not equipped with an "Engine Run" circuit breaker, the "Engine Run" circuit breaker on the lead GP9 must be "ON" to start and keep the fuel pumps of the trailing older type units running.

9. Check the PCS light - it should be OFF.

10. Test for water accumulation in engine cylinders
    a. Remove 400 ampere starting fuse.
    b. Open engine cylinder test valves (3 full turns), Fig. 2-1.



Cylinder Test Valves
Fig. 2-1

c. Rotate engine at least one complete revolution by use of the engine turning jack.

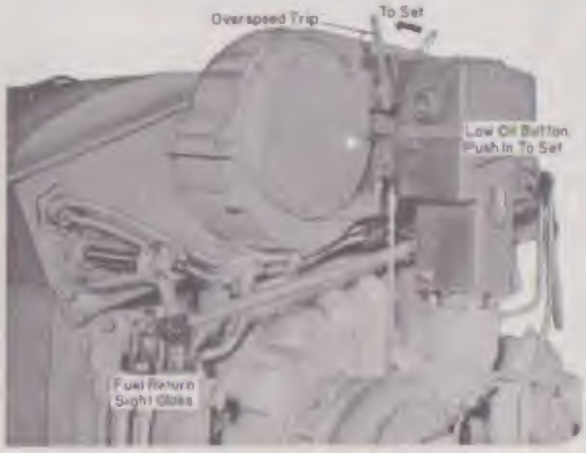
d. Watch the cylinder test valves while the engine is being rotated. If water is discharged from any test valve, do not attempt to start the engine until the cause of the water accumulation has been corrected.

e. Close cylinder test valves.

f. Replace 400 ampere starting fuse.

202 **To Start Engine** After completing the items mentioned in Art. 201, the engine is started by performing the following steps:

1. Check for fuel flow through "return fuel sight glass" on fuel filter mounted on front of engine, Fig. 2-2.
2. Check position of overspeed trip.
3. Check position of governor low oil trip button.

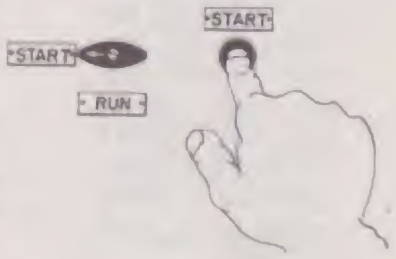


Overspeed Trip And Fuel Flow Check
Fig. 2-2

4. With the isolation switch in the START position, firmly press IN the engine START button and hold it in until engine completely starts (not over 15 seconds), Fig. 2-3.
5. After engine is started, check lube oil pressure.
6. Check for ground relay action.
7. Idle engine until temperature becomes normal.
8. See Section 3 if trouble is experienced in starting engine.

203 **Placing An Engine On The Line** Before the engineman can control the speed of the engine with the throttle lever, the engine must be placed "on the line," and the "Engine Run" circuit breaker must be in the "ON" position.

1. After the oil pressure has built up, the engine is placed "on the line", by merely placing the isolation switch in the RUN position, Fig. 2-4.
2. If an engine has been taken off the line for any reason, DO NOT place it "on the line" if the locomotive is being operated in dynamic braking.



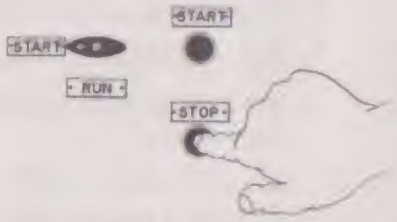
Starting Engine
Fig. 2-3

Placing Engine On-the-Line
Fig. 2-4

204 **To Stop Engine** There are three ways of stopping engine;

these can be designated as (1) normal (2) under power and (3) emergency.

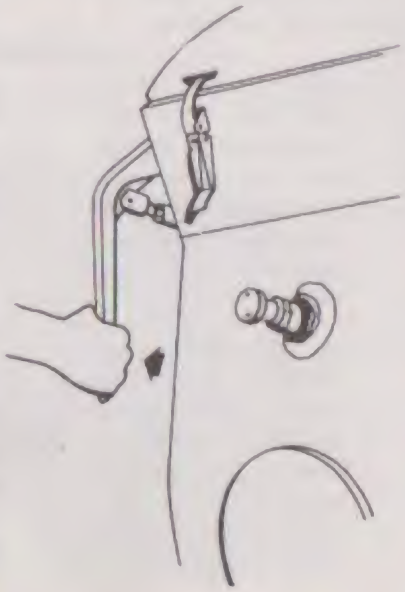
1. Normally stopping an engine applies when the locomotive is standing still. In this case place the isolation switch in the Start position and press in on the Stop button, in the electrical cabinet, until engine stops, Fig. 2-5.



Stopping Engine
Fig. 2-5

2. Under power, in dynamic braking, or whenever necessary, an engine can be taken "off the line" by pulling the engine manual lay-shaft closed until the engine stops, Fig. 2-6. After stopping the engine, place the isolation switch in the Start position.

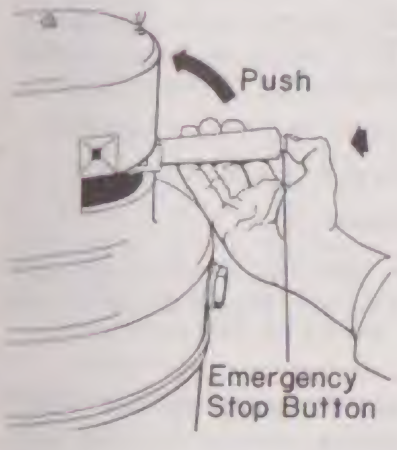
3. In an emergency all engines "on the line" are simultaneously stopped by depressing emergency stop button on the end of the throttle lever, Fig. 2-7, and pushing the throttle lever as far forward as possible to Stop position.



To Stop Engine
Fig. 2-6

205 **Securing Locomotive for Layover**

1. Place the reverse lever in Neutral position, and the throttle in Idle.
2. Place the selector lever in the OFF position, and remove the reverse lever from controller.
3. Place isolation switch in START and press Stop button IN until engine stops.



To Stop Engine
Fig. 2-7

4. Place all the circuit breakers at the engineman's control panel in the OFF position (down).
5. Open all the knife switches and circuit breakers in the electrical cabinet.
6. Apply hand brake and block the wheels, if necessary.
7. Cover the exhaust stacks, if there is danger of a severe rain.
8. Take the proper precautions against the freezing of the cooling system water in cold weather, see Art. 221.

HANDLING LOCOMOTIVE

206 **Precautions Before Moving Locomotive**

1. NEVER move a locomotive, under its own power, without having first observed proper application and release of the brake shoes.
2. Check the main reservoir and the control air pressure.

3. Release hand brakes and remove any blocking of the wheels.
4. Engine cooling water temperature should be normal.

207 **Handling Light Locomotive** With the engines placed "on the line" and cab preparations completed the locomotive is handled as follows:

1. Move 'Generator Field" circuit breaker to ON.
2. Insert and move the reverse lever to the desired position. (This lever is to be moved ONLY when the locomotive is standing still.)
3. Place the selector lever in the No. 1 position.
4. Depress safety control foot pedal (if used).
5. Release the air brakes.
6. When running light, open the throttle a notch at a time. When kicking cars etc., the throttle may be advanced as far and as rapidly as needed.

208 **Coupling To Train and Pumping Up Air** After coupling to a train, stretch coupling to make sure it is properly made. If main reservoir pressure falls below feed valve setting when brakes are cut in, proceed as follows:

1. Place 'Generator Field" circuit breaker in "OFF" position.
2. Place reverse lever in Neutral.
3. Open throttle to 4th, 5th or 6th notch as needed.

209 **Starting a Train** Starting a train depends not only on the kind of locomotive being used, but also on the type, length, weight, grade, weather conditions and the amount of slack in the train. Because of the lo-

comotive's very HIGH STARTING TRACTIVE EFFORT it is important that the air brakes be COMPLETELY released before attempting to start the train. Actual tests have shown that a 100 car train, having the average uniformly distributed leakage, may require 9 minutes to completely release the brakes. It requires approximately 30 minutes (with 130 pound main reservoir pressure) to completely charge a depleted air system on a similar 100 car train.

The load indicating meter, Fig. 2-8, can be used as a PULL METER to judge the tractive effort of the locomotive. Merely looking at the ground and listening to the engine exhaust may give a false indication of the locomotive's draw bar pull.

The GP9 locomotive is designed to have a COMPARATIVELY RAPID YET SMOOTH BUILD UP OF POWER. Load regulator timing is quite fast in moving from minimum to maximum and somewhat slower from maximum to minimum. This is due to a special design pilot valve bushing in the governor.

With this arrangement a power build-up equal to the throttle position is very quickly obtained. Any fur-

Load Indicating Meter
Fig. 2-8

ther advancement of the throttle is accompanied by an almost immediate additional increase in power. This may be seen by observing the speed with which the load indicating meter responds to throttle advance.

With a power control of this type the rate and extent of power build-up is left largely to the desire of the engineman yet is still controlled by the load regulator and engine governor.

When ready to start, the following general procedure is recommended:

1. Place the selector lever in the No. 1 position and move the reverse lever to the desired direction.
2. Place foot on the safety control foot pedal (DEADMAN) and release the brakes.
3. Open the throttle one notch every 1 to 2 seconds as follows:
   a. To Run 1 - note the load meter pointer start moving to the right.
   b. To Run 2 - note engine speed increase. At an easy starting place, the locomotive may start the train in Run 1 or 2.
   c. To Run 3 or higher (experience and the demands of the schedule will determine this) until the locomotive moves.
4. Reduce throttle one or more notches if acceleration is too rapid.
5. After the train is stretched, advance throttle as desired.

NOTE: If the wheel slip indicator flashes continuously, reduce the throttle one notch. Apply sand as needed to prevent further slipping and reopen the throttle when rail conditions improve. See Art. 210 - Automatic Sanding In Power.

Although it will generally be unnecessary to take slack in starting, there will be cases where it is wise to do so, after making sure that all brakes are released. The throttle should be opened one notch at a time, in starting the train. A TONNAGE TRAIN SHOULD BE STARTED IN AS LOW A THROTTLE POSITION AS POSSIBLE, BEARING IN MIND THAT THE SPEED OF THE LOCOMOTIVE MUST BE KEPT AT A MINIMUM UNTIL THE TRAIN HAS BEEN STRETCHED. Sometimes it is advisable to reduce the throttle a notch or two the moment the locomotive begins to move, in order to prevent stretching the slack too quickly. The engineman must be the judge of the acceleration and the conditions under which the train is being started.

When the locomotive has moved far enough to completely stretch the train, the throttle may be advanced as quickly as desired, but should not be advanced so quickly that slipping results. Smooth acceleration is obtained by opening the throttle one notch each time the pointer of the load meter begins moving to the left.

210 **Automatic Sanding in Power** GP9 locomotives are equipped with automatic sanding in power to assist in controlling wheel slip. When operating in transition one (1) (as in starting a train) sanding automatically takes place while slip is in its "creep" or initial stage. In this manner a wheel slip is "anticipated" and prevented before any appreciable loss of tractive effort occurs.

In transition 2, 3, and 4 (and on some occasions in transition 1) automatic sanding, caused by wheel slip, is accompanied by a reduction in main generator output.

Duration of sanding, after the wheel slip or creep has stopped, is controlled by the setting of a time delay sanding (TDS) relay. An off-on circuit breaker switch on the engineman's control panel cuts in or out this sanding-in-power feature.

With the automatic sanding feature "cut-in" (Auto-Sanding circuit breaker in ON position) throttle reduction to avoid repeated wheel slip will rarely be necessary. Also, manual operation of the sanders by the engineman at points on the road where slippage is likely to occur can be eliminated.

211 **Acceleration of a Train** After the throttle is in the 8th notch and the train begins to accelerate, the indicating meter pointer will move slowly to the left. Forward and backward transition will automatically take place without any attention on the part of the engineman, other than necessary throttle reductions to keep under any speed restriction.

212 **Slowing Down Because of a Grade**

1. As the train slows down on a grade the pointer on the indicating meter will move slowly toward the right. Backward transition will take place automatically.

213 **Locomotive Operation At Very Slow Speeds**
The operation of a GP9 locomotive, regardless of gear ratio, is not governed by any specific short time ratings.

In most cases, the locomotive may be operated up to the limit of the adhesion attainable.

GP9 locomotives pulling tonnage trains at very slow speeds should be operated with the throttle in Run 8 position. In the event of a wheel slip indication (wheel slip light flashes on), the locomotive wheel slip control system will automatically apply sand to the rails (Auto.-Sand. circuit breaker in ON position) and reduce power to a point where slipping stops. If continuous wheel slipping on sand occurs, due to unusual rail operating con-

ditions, the throttle can be reduced. Under these circumstances, the GP9 locomotive can operate at reduced throttle, provided it is not necessary to reduce below the 5th throttle notch to correct for a continuous wheel slip.

If there are any questions about an unusual operation of the locomotive, such as a passenger locomotive operating in freight service, Electro-Motive will, upon request, analyze the actual operation and make specific recommendations.

BRAKING

214 **Air Braking With Power** The method of handling the air brake equipment is left to the discretion of the individual railroad. However, when braking with power it must be remembered that for any given throttle position the draw bar pull rapidly increases as the train speed decreases. This pull might become great enough to part the train unless the throttle is reduced as the train speed drops. Since the pull of the locomotive is indicated by the amperage on the load meter, the engineman can maintain a constant pull on the train during a slow down, by keeping a steady amperage on the load meter. This is accomplished by reducing the throttle a notch whenever the amperage starts to increase. It is recommended that the independent brakes be kept fully released during power braking. The throttle MUST be in Idle before the locomotive comes to a stop.

MISCELLANEOUS OPERATING INSTRUCTIONS

215 **Multiple Unit Operation** In operating GP9 units in multiple with each other or with GP7 units, the operating controls of the locomotive are set up as outlined in Art. 217. When set up for multiple unit operation, the following operating precautions should be observed.

If the units of the consist are of different gear ratios, the locomotive should not be operated at speeds in excess of that recommended for the unit having the lowest maximum permissible speed.

If some of the units in the consist have an overload short time rating, the locomotive operation should be governed by the overload short time rating of the unit having the highest maximum permissible speed.

216 Uncoupling and Coupling Units in Locomotive

1. To uncouple units:
   a. Apply brakes and close angle cocks on both units on all air hoses.
   b. Take down all power plant jumper cables.
   c. Remove platform safety chains between units.
   d. Break hoses and separate units by uncoupling.

2. In coupling units:
   a. Couple and stretch units to insure couplers are locked.
   b. Connect hoses and jumpers, and be sure all necessary angle cocks are opened.
   c. Attach platform safety chain between units.
   d. In any non-operating cab, cut-out the brakes and place all circuit breakers at the engineman's control panel in "OFF" position. Remove the reverse lever from the controller in all trailing units.

217 Changing Operating Ends When the consist of the locomotive includes two or more units with operating controls, the following procedure should be followed in changing from one operating end to the opposite end.

1. Locomotives equipped with 24RL brake.
   a. If the locomotive is equipped with electro-pneumatic brakes and the brake has been in use, change the brake selector on the automatic brake valve to "AUTO" and open electro-pneumatic brake switch.
   b. REMOVE REVERSE LEVER.
   c. With safety control foot pedal depressed, make an automatic 20 pound brake pipe reduction.
   d. Move the independent brake valve handle to release position; observe that the locomotive brakes are still applied.
   e. Release safety control foot pedal.
   f. Close brake pipe cut-out cock (double heading cock).
   g. Move the rotair valve to the "Passenger Lap" or "Freight Lap" position depending on the service required.
   h. Move the automatic brake valve handle to the RUNNING position and remove the handle from the brake valve.
   i. Remove the independent brake valve handle in the RELEASE position.
   j. Place all circuit breakers at the engineman's control panel in OFF position.
   k. Place "Headlight Control" switch in "Controlled" position.
   l. Proceed to cab at opposite end. Check the PC switch light. Move "Control and Fuel Pump" and "Engine Run" circuit breakers, on the engineman's control panel, to ON position and any other circuit breakers that are necessary.
   m. Insert reverse lever, automatic brake valve and independent brake valve handles.
   n. Move the rotair valve to the "FRGT." or "PASS." position, depending upon the service required.

o. Place the independent brake valve handle in the FULL APPLICATION position.
p. Open brake pipe cut-out cock (double-heading cock), slowly, pausing from five to ten seconds in mid-position.
q. Place unit selector switch in proper position if locomotive is equipped with dynamic braking.
r. Place "Headlight Control" switch in proper "Controlling" position.
s. When ready to move locomotive, depress safety control foot pedal or automatic brake valve handle and move the independent brake valve handle to RELEASE position.

2. Locomotives equipped with 6BL brake.
a. REMOVE REVERSE LEVER.
b. Make a full service brake pipe reduction.
c. Move double heading cock to "Trailing" (4 o'clock) position and release safety control foot pedal (if used).
d. Move the independent brake valve handle to RELEASE position.
e. Leave the automatic brake valve handle in the LAP position.
f. Place all circuit breakers at engineman's control station in "Off" position.
g. Place "Headlight Control" switch in "Controlled" position.
h. Proceed to cab at opposite end. Check "PC" switch light. Move "Control and Fuel Pump" and "Engine Run" circuit breakers to ON position and any other circuit breakers that are necessary.
i. Insert reverse lever and brake valve handles. Place independent brake valve in FULL APPLICATION position.
j. Open double heading cock to "Lead" (6 o'clock) position slowly.
k. Place automatic brake in RUNNING position.

l. Place unit selector switch in proper position if locomotive is equipped with dynamic braking.
m. Place "Headlight Control" switch in proper "Controlling" position.
n. When ready to move locomotive, depress safety control foot pedal (if used), and move independent brake valve to RELEASE position.

NOTE: When the 6BL brake is equipped with safety control foot pedal or automatic train control, the N-1-A brake application valve is used. The three-position brake valve cut-out cock (double heading cock) is mounted on this N-1-A brake application valve instead of on the automatic brake valve. This cut-out cock is accessible through a small trap door in the cab floor.

218 Handling Locomotive Dead-In-Train

1. Air brake equipment.
   a. Place the independent and automatic brake valve handles in the Release and Running positions respectively.
   b. Move the double heading cock to the "Cut-out" (24RL) or "Dead" (6BL) position.
   c. Open the dead engine cut-out cock.
   d. If the locomotive is equipped with 24RL brake, move the Rotair valve to the passenger (PASS) position.

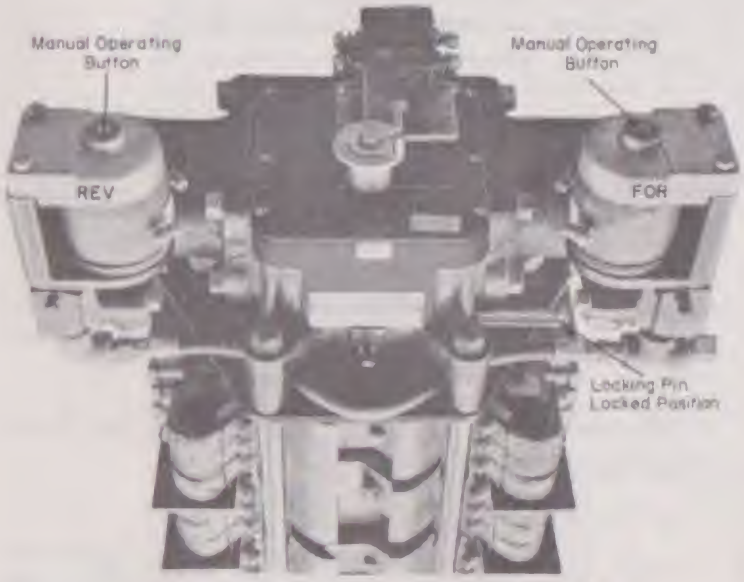
The locomotive brake will now operate like that of a car in the train.

2. Electrical control equipment.
   a. Remove the reverse lever from the controller.
   b. Place the isolation switch in the Start position. If it is necessary to keep the engine

idling while hauling locomotive, the "Control and Fuel Pump" circuit breaker must be left ON.

c. If locomotive is to be hauled in a train any appreciable distance, reverser switch, Fig. 2-9, should be placed in Neutral and locked in that position. Center the reverser drum switch in neutral by manually operating the forward and reverse magnet valve buttons.

To lock the reverser switch in neutral, remove the locking pin which during normal operation is screwed into the left hand side of the reverser housing. With the reverser drum switch in neutral, insert pin into hole in the right side of reverser housing. Push pin in all the way through the reverser switch shaft and screw pin into threaded hole.



Reverser Switch – Locked in Neutral
Fig. 2-9

219 **Doubleheading** Prior to double heading behind another locomotive, make a full service brake pipe reduction with the automatic brake valve and close the double heading cock. On locomotives equipped with 24RL brake, leave the Rotair valve in FRGT. or PASS. position depending upon the service required. Return the automatic brake valve handle to the running position and place the independent brake valve in release position. The operation of the throttle is normal, but the brakes are controlled from the lead locomotive. The engineman on the second locomotive may make an emergency application of the brakes with automatic brake valve, and/or may release his locomotive brakes by depressing the independent brake valve handle, in the release position.

220 **Operation In Helper Service** Basically, there is no difference in the instructions for operating the GP9 locomotive as a helper or with a helper. In most cases the GP9 locomotive can be operated in either service up to the limit of the adhesion attainable. The throttle can be reduced to prevent excessive wheel slip, but the locomotive should not be operated below the 5th throttle position.

If other Diesel locomotives having overload short time ratings are used with the GP9 locomotive in helper service, their operation will be governed by the permissible length of time the locomotives can operate at the short time ratings. The throttle must be successively reduced as the higher short time ratings are consumed but the locomotives should not be operated below the 5th throttle position.

To obtain a maximum tonnage rating for any single application, Electro-Motive will, upon request, analyze the actual operation and make specific tonnage rating recommendations.

221 **Freezing Weather Precautions** In freezing weather, precautions must be taken to see that

water in the locomotive does not freeze when the engine is shut down for any reason. If trainline steam is not available, the entire system will have to be drained.

A. With steam from an external source supplied to the locomotive (engine and steam generator shut down) to prevent freezing, the following valves are to be opened:

1. Engine cooling system.
   a. Steam admission valve to engine cooling water.
   b. "G" valve.
   c. Toilet water tank steam valve.

2. Steam generator.
   a. Heating coil valve.
   b. Water suction line valve.
   c. Water tank valve.
   d. For detailed instructions, see Section 6.

B. In freezing weather if heating facilities are not available, all water must be drained from:

1. Engine cooling system. Also, remove pipe plug from bottom of right water pump housing.
2. Steam generator (see Steam Generator Section).
3. Steam generator water tank.
4. Toilet water tank.
5. Air system.
   a. Air compressor oil separator.
   b. Sump reservoir.
   c. Main reservoirs.
   d. Type H filter.
   e. Electrical control air regulator.
   f. Electrical control air reservoir.
   g. Air compressor intercooler.
   h. Air strainers.

222 **Operation Over Railroad Crossings** When crossing railroad crossings, reduce throttle to the 5th notch before reaching crossing and leave reduced until all locomotive units are over crossing. This will reduce arcing from the brushes to the motor commutator.

223 **Running Through Water** Under ABSOLUTELY NO circumstances should the locomotive pass through water which is deep enough to touch the bottom of the traction motor frames. When passing through water, always go at a very slow speed (2 to 3 miles per hour). Water any deeper than three inches above the top of the rails is likely to cause damage to the traction motors.

224 **Resetting PC Switch After Safety Control Application**

1. CLOSE THROTTLE TO IDLE.
2. Place automatic brake valve in LAP.
3. Place foot on safety control foot pedal (if used).
4. Wait until application pipe pressure is normal. Listen for exhaust or watch the "PC Switch Open" light. If the PC switch does not reset itself with the automatic brake valve in LAP, move the brake valve to the RUNNING position. The PC switch is properly set when the light goes out.

225 **Ground Relay Action** When this protective device is tripped the engine will not speed up when throttle is opened and no power will be developed; the alarm bell will ring and the ground relay light (White) on the engineman's control panel will be on. If the ground relay trips, while the throttle is in Run 5 or 6, the engine will stop. The relay indicator points to a yellow dot when set, and to a red dot when tripped. To

reset: isolate engine, depress relay reset button and put engine "on the line." If relay continues to trip isolate unit.

226 **Wheel Slip Indication** The wheel slip light will flash on immediately when a pair of wheels has slipped. The detection of wheel slip action automatically reduces the application of power to stop the slipping; the power will be reapplied after slipping has stopped.

It will generally be unnecessary to reduce the throttle because of momentary wheel slip action. Sand may be applied to prevent repeated wheel slipping which may occur under extremely poor rail conditions.

227 **Indication of a Pair of Wheels Sliding** If one pair of wheels should slide when starting a train, the wheel slip light will flash on and off intermittently. As the train speed increases, the light will stay on more or less continuously and will not go out when the throttle is reduced. The light will go out when throttle is closed to idle.

If sliding is suspected, the engine crew should make an immediate investigation to determine the cause. The wheels may be sliding due to a locked brake, a broken gear tooth wedged between the pinion and ring gear, etc.

Repeated ground relay action, accompanied with unusual noises such as continuous thumping or squealing, may also be an indication of serious traction motor trouble that should be investigated at once.

IF AN ENGINE MUST BE ISOLATED BECAUSE OF REPEATED WHEEL SLIP OR GROUND RELAY ACTION, DO NOT ALLOW THAT UNIT TO REMAIN IN THE LOCOMOTIVE CONSIST UNLESS IT IS CERTAIN THAT ALL OF ITS WHEELS ROTATE FREELY.

228 **Air Box Drains**

Air Box Drain Valve
Fig. 2-10

The engine air box accumulation settles in two drain tanks incorporated in the engine oil pan near the generator end, one on each side. Two air box drain valves, Fig. 2-10, permit draining of these tanks. The tanks should be drained periodically when the locomotive is standing still. With the air box drain valves open, observe the drain pipe discharge under the locomotive to determine if there is any water or an excessive oil accumulation in the air box. If a discharge is observed from the drain pipes under the locomotive with the air box drain valves closed (accumulation flowing through overflow pipe), the air box accumulation should be investigated.

OPERATION OF LOCOMOTIVE "EXTRAS"

GP9 locomotives can on special order be equipped with dynamic brakes, hump speed control, motor lockout switches and dual cab controls.

229 **Dynamic Brake Operation** Dynamic braking is an electrical hookup used to change some of the power developed by the momentum of a moving locomotive into an effective holding brake. The traction motor armatures, being geared to the axles, are rotating whenever the train is moving. When using dynamic brake, electrical circuits are set up which change the traction motors into generators. Since it takes power to rotate a generator, this action retards the speed of the train. The dynamic brake is, in effect, very similar to an independent brake, and the load indicating meter serves the purpose of a "brake cylinder pressure gauge."

In descending a grade, with throttle in Idle position, drawbar "push" of the trailing train tonnage moves the locomotive forward. If no resistance other than the locomotive and the wheel friction is exerted against this "push," the momentum of the train on the descending grade would soon reach a speed where the train brakes would have to be applied. In dynamic brake, a resistance to this drawbar push is set up which in effect "holds back" the speed of the train as would the application of the locomotive independent brake. The effect of the resistance is to slow down the traction motor armatures being driven by the "push" of the train.

The resistance set up in each traction motor is a magnetic field through which the traction motor armature must rotate. Increasing the strength of the magnetic field will effect a "slow down" of the traction motor armature, thus holding back the train. The magnetic field is produced by connecting the traction motor fields of each unit in series with the main generator, and passing a current through these fields. The strength of the magnetic field is varied by varying the main generator current to the traction motor fields in each unit.

The main generator battery field of each unit in the locomotive consist is connected in series to the low voltage supply of the lead unit. This is called the "field loop" circuit. Movement of the selector lever in the lead unit toward the "B maximum" braking position, increases the battery field excitation of each main generator, which in turn increases the main generator current to the traction motor fields. Thus, in effect, the strength of the magnetic field through which the traction motor armature must rotate, is controlled by the movement of the selector lever in the braking position. Moving the selector lever toward the "B maximum" position increases the effectiveness of the "holding brake."

In dynamic brake, the traction motor armatures are connected to grids located in the top of the carbody. Rotation of the armature through the magnetic field generates power (braking current) and this current flows

through the grids to be dissipated as heat. The braking current generated increases as the armature rotation increases (momentum of train increases the drawbar push) or as the strength of the magnetic field is increased (engineman advances selector handle toward "B maximum" position). The maximum braking current that can flow through the grids is automatically limited to 700 amperes regardless of locomotive speed or selector lever position.

To operate the dynamic brake on locomotives so equipped, proceed as follows:

1. Position the unit selector switch, Fig. 2-11, in the lead unit to correspond to the number of units in the locomotive consist.
2. Reverse lever should be positioned in the direction of locomotive movement.
3. Throttle must be reduced to Idle.
4. Move selector lever from "No. 1" to "Off" position; pause 10 seconds before proceeding to Step 5.
5. Move selector lever to the "B" position. (In the "B" position the dynamic braking circuits are partially established and depending on the speed of the train, enough braking may be present to bunch the slack. In this position, the brake transfer switch (BKT) is moved to the "brake" position. Movement of the "BKT" to "brake," disconnects the traction motor armatures from the motor fields and connects the armatures to the grids. The traction motor fields of each unit are connected in series to the main generator of that unit. The main generator battery field of each unit in the consist is connected in series to the low voltage supply of the lead unit, but, the selector handle must be moved beyond the "B" position to excite this battery field circuit.)

6. After slack is bunched, the lever may be moved farther to the right to give the desired amount of braking effort. (The speed of the diesel engine is increased from 275 RPM (Idle) to 435 RPM automatically as the selector handle is moved beyond the "B" position).

7. Observe the braking amperage (braking effort) on the load indicating meter. The braking amperage is automatically limited to a maximum braking effort of 700 amperes regardless of locomotive speed or selector handle position.

8. If maximum braking is desired, the selector handle should be moved to the full "B maximum" position. The selector handle should always be moved SLOWLY to prevent a sudden surge of current in excess of the maximum brake current rating. Generally, if the selector handle is moved slowly to the full "B maximum" position, the brake current limiting regulator will limit the braking current to a maximum 700 amperes and no brake warning indication of excessive braking current will be given. However, if the brake warning light flashes on, movement of the selector handle should be stopped until the light goes out.

   If the light fails to go out after several seconds, move selector handle back toward "B" position slowly until the light does go out. After the brake warning light goes out, the selector handle may again be moved slowly toward the full "B maximum" position.

9. When necessary, the automatic brake may be used in conjunction with the dynamic brake. However, the independent brake must be KEPT FULLY RELEASED whenever the dynamic brake is in use, or the wheels may slide. As the speed decreases below 10 miles per hour the dynamic brake becomes less effective. When the speed further decreases, it is permissible

to completely release the dynamic brake by placing the selector lever in the "OFF" or "No. 1" position, applying the independent brake simultaneously to prevent the slack from running out.

NOTE: The most effective use of the dynamic brake is between 15 and 25 miles per hour depending on the gear ratio. Speed on grades should not be allowed to "creep up" by careless handling of the brake, as this is a holding brake and is not too effective in slowing down heavy trains on steep grades.

GP9 locomotives can be operated in dynamic braking coupled to older units that are not equipped with brake current limiting regulators. If all the units are of the same gear ratio, the unit having the lowest maximum brake current rating should be placed as the lead unit in the consist. The engineman can then operate and control the braking effort up to the limit of the unit having the lowest brake current rating, without overloading the dynamic brake system of a trailing unit. The locomotive consist MUST always be operated so as not to exceed the braking current of the unit having the lowest maximum brake current rating.

Units equipped with dynamic brake current limiting regulators can be operated in multiple with GP9 locomotives in dynamic braking regardless of the gear ratio, or difference in the maximum brake current ratings.

Units not equipped with dynamic brake current limiting regulators and of different gear ratios will require special operating instructions when used in multiple with a GP9 locomotive in dynamic braking.

230 **Dynamic Brake Selector Switch** The dynamic brake unit selector switch, Fig. 2-11, located at the

engineman's control station, has four positions (1, 2, 3 and 4) and should be set to correspond with the number of units in the locomotive consist. This switch should be set before leaving the terminal and must not be changed even if an engine is isolated enroute. This switch is changed only if number of units in the locomotive consist is changed.

Unit Selector Switch
Fig. 2-11

231 **Dynamic Brake Warning Light** In dynamic braking, the wheel slip light on engineman's control panel is also used to indicate an excessive braking current. Generally, the over-current is only temporary, and the dynamic brake current limiting regulator will automatically reduce the braking current to a maximum 700 amperes.

Dynamic Brake Grid Blower
Fig. 2-12

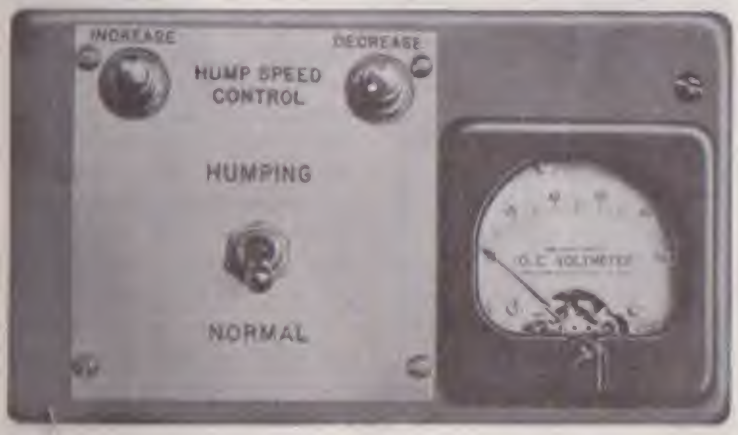
232 **Dynamic Brake Grid Blower** The grids are cooled by a motor driven fan, Fig. 2-12. The grids and fan are located in the top of the carbody directly above the center of the engine. Power generated by the No. 1 and 3 traction motors drives the grid blower motor.

233 **Dynamic Brake Wheel Speed Control** The relays used to correct a wheel slip while under

power are also used to correct the tendency of one pair of wheels to rotate slower while in dynamic braking due to an unusual rail condition.

When a pair of wheels is detected tending to rotate at a slower speed, the retarding effort of the traction motors in the unit affected is reduced (main generator battery field excitation is reduced in the unit affected) and sand is automatically applied to the rails ("Automatic Sanding" circuit breaker on engineman's control panel must be in "ON" position). When the retarding effort of the traction motors in the unit is reduced, the tendency of the wheel set to rotate at a slower speed is overcome. After the wheel set resumes normal rotation, the retarding effort of the traction motors returns (increases) to its former value. Automatic sanding continues for approximately 20 seconds after wheel speed is corrected.

234 **Hump Speed Control** When used, the electrical hump speed control circuit controls the positioning of the load regulator thereby controlling the excitation to the main generator. The hump speed controls are shown in Fig. 2-13. For maximum performance during



Hump Speed Control
Fig. 2-13

hump operation, open the throttle to the minimum position that is sufficient to bunch the slack and move the cut of cars up the hump. It is assumed that time and distance will permit the load regulator to reach a balanced position of full loading for that throttle position. Move toggle switch, Fig. 2-13, from NORMAL to HUMPING position. The voltmeter on the hump control panel will show the amount of excitation voltage to the main generator. As cars are pushed over the hump and "cut off," the train load lessens in small increments of the total starting load. Power output of the locomotive must accordingly be reduced in small increments to avoid excessive speed. Accomplish this by momentarily depressing the DECREASE button as conditions dictate. It will be noted that voltage, as shown on voltmeter, will eventually decrease to a certain (less than 10 V.) minimum. Should the speed become excessive even with the DECREASE button depressed and voltage at minimum (less than 10 V.) reduce the throttle one or more notches.

From this it can be seen that a combination of throttle setting (i.e. engine RPM) and applied voltage (main generator excitation voltage) produce the power to move the train. Locomotive power can be reduced by reducing the throttle setting; however, reducing power in smaller increments better suits the operating conditions peculiar to humping service. Reducing the excitation voltage a few volts at a time as the load lessens makes possible a fine balance between power output and power required.

Actual operating experience may show that variations of the preceding method of operation are desirable. One such variation is obtained by placing the toggle switch in HUMPING before opening the throttle. With this method the load regulator will remain in minimum field necessitating the use of the INCREASE button until main generator power output is sufficient to move the train. Once again as the load lessens, the DECREASE button must be used to keep the train speed consistent

with the railroads specific humping speed. Throttle position will be dictated by starting tonnage and grade and curvature of the hump yard lead or approach track.

The hump control toggle switch on the control stand not being used, on dual control locomotives, must be in the normal position.

235 **Motor Lock-Out Switches** Four motor lockout switches (CO1, CO2, CO3 and CO4) are mounted on the reverser drum, Fig. 2-14. Each switch permits the isolation of the corresponding traction motor from the power circuit (CO1 cuts out traction motor No. 1) in the event that a traction motor is grounded. Always isolate the engine before opening a motor lockout switch. Not more than one traction motor should be cut out at any time, and the armature of the traction motor to be cut out must be free to rotate.

Motor Lockout Switch
Fig. 2-14

236 **Dual Cab Control Operation** Dual controls in the cab enable the locomotive to be operated from either control station thereby allowing the engineman to choose his control station depending on the direction in which the locomotive is to be operated.

Two identical control and brake stands are provided in the cab of the locomotive. Both the control

stations are equipped with load indicating meters but only one control stand is equipped with a speed recorder; the other stand is equipped with a speed indicator. This allows the engineman to observe his speed at either control stand. If the locomotive is equipped with over-speed control, the speed recorder will govern the maximum speed regardless of locomotive direction.

The circuit breakers on the two engineman's control panels in the cab of these locomotives are connected in series; the proper circuit breakers at both control stations must be in the "ON" position in order to operate the locomotive.

To facilitate the operation of the various circuit breakers in the two control panels it is recommended that ALL circuit breakers at the NON-OPERATING control station be placed in the "ON" position. The engineman may then turn on ONLY those circuit breakers at the OPERATING control station that are necessary for the operation of the locomotive. In this manner the engineman will be able to instantly turn "ON" or "OFF" any item from the operating control station where he is located.

When changing operation from one control station to the other the procedure for handling the throttle, selector and reverse levers and the brake equipment is the same as that given for changing ends (Art. 217) with the following exceptions:

1. The circuit breakers should be handled as mentioned in the preceding paragraph.
2. With 24 RL brake equipment the rotair valve is NOT to be moved to either of the "LAP" positions, as there is only one rotair valve on GP7R locomotives equipped with dual controls.
3. With 6BL brake equipment, if each brake equipment stand is equipped with a three-position

doubleheading cock, the doubleheading cock at the non-operating control station should be placed in "Dead" position. If the 6BL brake equipment is arranged for safety control applications, there will be only one three-position doubleheading cock located on the N-1-A brake application valve. This cut-out cock is accessible through a small trap door in the cab floor and should be placed in the "Lead" position.

When changing ends in multiple unit operation, the procedure outlined in Art. 217 must be followed completely, with the understanding that all circuit breakers at the dual control stations are to be placed in the "OFF" position in the unit that is being made inoperative.

SECTION 3

LOCATION AND CORRECTION OF DIFFICULTIES ON-THE-ROAD

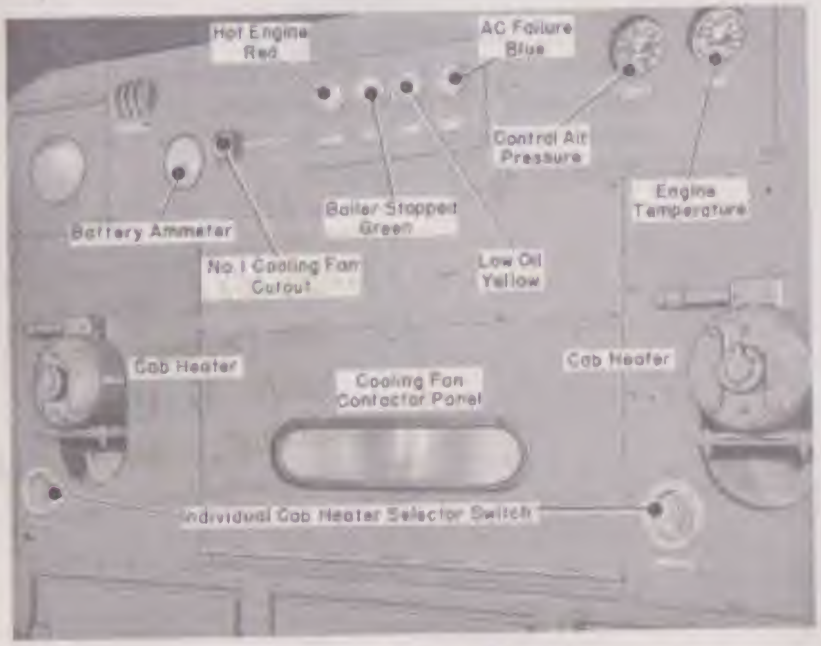
This section provides a check list calling the operator's attention to the troubles which are most frequently encountered on the road, and which can be quickly remedied thereby eliminating many delays.

No attempt is made to explain general operation and functions of equipment on the locomotive. For such information refer to the other sections of this manual.

300 GENERAL. Safety devices automatically protect the equipment in case of the faulty operation of most any component. In general, this protection is obtained by unloading or preventing the loading of the Diesel engine so that the locomotive loses its pulling power. The locomotive can lose its power with the Diesel engine still running or stopped. An exception is a hot engine alarm which does not reduce the engine load or speed. The trouble shooting check chart, at the end of this section, pages 313-314, outlines the possible causes of trouble should the locomotive suddenly lose its power, with the diesel engine running or stopped.

When trouble is experienced, the general location and type of difficulty is often indicated by the ringing of an alarm bell and the lighting of one or more signal lights in the troubled units. The signal lights, located on the rear cab wall, Fig. 3-1, and the engineman's control panel, Fig. 3-2, are as follows:

a. Hot Engine - RED
b. Boiler Stopped - GREEN
c. Alternator Failure - BLUE
d. Low Oil - YELLOW
e. Ground Relay - WHITE
f. PC Switch - WHITE



Rear Wall Of Operating Cab
Fig. 3-1

NOTE: All the circuit breaker switches, on the engineman's control panel, Fig. 3-2, trip open at 15-amperes; except the "Control And Fuel Pump", and "Generator Field", which are 30-ampere circuit breakers.

The circuit breaker switches are ON (closed) when in the UP position; OFF-DOWN.

If a circuit breaker is overloaded and trips open, service is restored by first placing switch fully OFF and then moving it to ON.

301 **If Alarm Bells Ring** An alarm signal light will be illuminated in the unit affected.

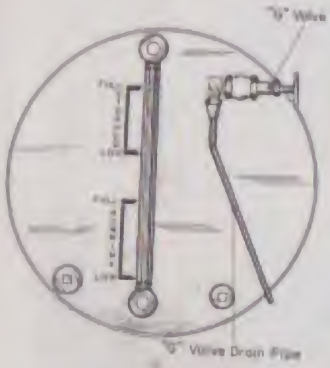
RED—Hot Engine Indicates the outlet engine water

Engineman's Control Panel
Fig. 3-2

temperature is about 208° F. A hot engine alarm does not reduce the engine load or speed. The alarm signal will not stop until temperature returns to normal.

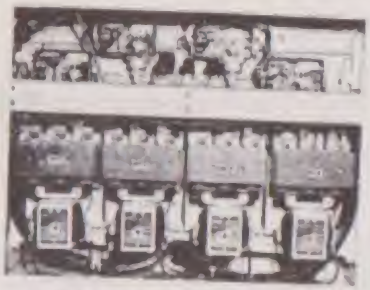
In case of hot engine alarm, proceed as follows:

1. Isolate engine; Isolating the engine will not stop alarm bell; temperature must return to normal.
2. Check the engine cooling water tank for correct level, Fig. 3-3. If there is sufficient water in the system, allow the engine to run at IDLE speed.



Cooling Water Levels
Fig. 3-3

3. AC cooling fan contactors must be closed, Fig. 3-4.
4. See that all shutters are open. If closed, check position of "shut off" valve in the air supply pipe to the shutter magnet valve.
5. The "Control and Fuel Pump" circuit breaker must be ON.



AC Cooling Fan Contactors
Fig. 3-4

GREEN—Boiler Stopped

Indicates steam generator has stopped. To stop alarm light and bell, turn boiler switch OFF, Fig. 3-5. To correct, see Steam Generator Trouble Shooting Chart Section 6.

Boiler Switch
Fig. 3-5

BLUE—Alternator Failure This alarm signal indicates that the alternating current system has failed; traction motor blowers and radiator cooling fans have stopped; No Voltage Relay (NVR) is opened (de-energized), Fig. 3-6. The engine speed and load is automatically reduced equivalent to No. 1 throttle position. The engine will STOP if the "AC" system fails with the throttle in Run 5 or 6. Placing the isolation switch in START stops the alarm signals.

NVR Relay
Fig. 3-6

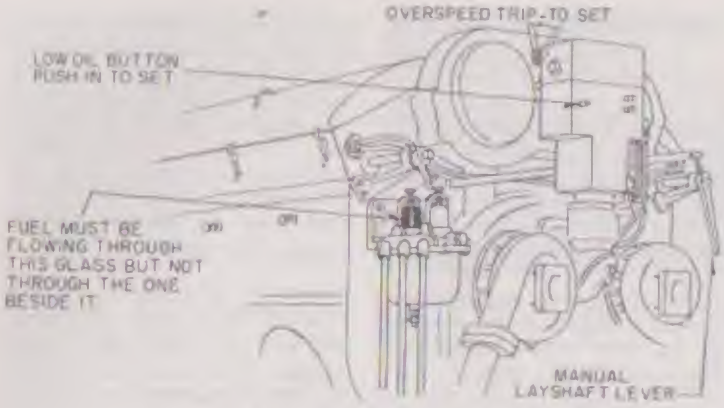
Most "Alternator Failure" alarms are "false" since this alarm occurs if the engine is stopped for any reason while "on the line." With an "Alternator Failure" alarm and the engine stopped, ALWAYS isolate and check cause of engine stopping. Check (a) overspeed trip, (b) throttle must not be in STOP position, and (c) fuel flow through fuel return sight glass, Fig. 3-7, before trying to start engine that has shut down with no indication other than an "Alternator Failure." If other alarm indications are present with the "Alternator Failure" alarm, they must also be checked before starting the engine.

A "TRUE" AC failure is evident when the Blue light and alarm bell are ON with the engine running and the isolation switch in RUN. To correct a "TRUE" AC failure, proceed as follows:

1. Isolate engine.
2. Check "Auxiliary Generator Field" circuit breaker; must be ON, Fig. 3-8.
3. Check "Alternator Field" circuit breaker; must be ON, Fig. 3-8.
4. Auxiliary generator output fuse must be good, Fig. 3-9. To check, open auxiliary generator knife switch, remove fuse and test it on fuse test clips in electrical cabinet. If defective, insert good spare fuse and close auxiliary generator knife switch.

NOTE: If "Engine Run" circuit breaker is OFF, or PC light is ON (PC switch open) the "Alternator Failure" alarm signals are inoperative.

YELLOW—Low Oil The tripping of the gov-



Overspeed Trip And Fuel Flow Check
Fig. 3-7

ernor low oil alarm button, Fig. 3-10, due to engine low oil pressure or high oil suction, will always stop the engine and the yellow indicating light will flash ON. The alarm bell will also ring if the isolation switch is in RUN position.

To correct, proceed as follows:

1. Place isolation switch in START.
2. Reset low oil trip button.

Circuit Breakers
Electrical Cabinet
Fig. 3-8

Battery Switch Panel
Fig. 3-9

3. Check engine lubricating oil level on engine oil pan dipstick, Fig. 3-11.

Lube Oil Button
Fig. 3-10

Engine Oil Pan Dipstick
Fig. 3-11

4. Check for broken or cracked oil lines.

5. Restart engine.

6. Check oil pressure (must be a minimum of 6 p.s.i. at IDLE).

NOTE: Do not repeatedly start engine if the LOW OIL button keeps shutting the engine down.

WHITE—Ground Relay When the ground relay light on the engineman's control panel flashes ON, it indicates that the ground relay located in the electrical cabinet has tripped (white indicator pointing to red dot), see Fig. 3-12. The engine speed and load will automatically be reduced to IDLE, or to STOP if the throttle is in Run 5 or 6. When the ground relay trips, the white Ground Relay Light on the engineman's control panel, Fig. 3-2, will flash ON. The alarm

Ground Relay
Fig. 3-12

bell will ring only if the isolation switch is in the "RUN" position, and the "Engine Run" circuit breaker is ON.

To correct: Isolate engine, reset ground relay, start engine if necessary and place engine "on the line." If the ground relay continues to trip, reset to stop the alarm, and leave engine isolated.

UNDER NO CONDITION OF REPEATED WHEEL SLIP ACTION OR GROUND RELAY ACTION SHOULD A UNIT BE ISOLATED AND ALLOWED TO REMAIN IN CONSIST UNLESS IT IS CERTAIN THAT ALL OF THE WHEELS ARE ROTATING FREELY.

ADDITIONAL SAFETY DEVICES

302 **"PC" Switch Open** The "PC" switch is an air operated electric switch that is tripped open by any "penalty" or "emergency" air brake application. When tripped, the white "PC light" on the engineman's control panel, Fig. 3-2, will flash ON, but the alarm bell will not ring. The engine speed and load are automatically reduced equivalent to throttle position No. 1. If the PC switch tripped open with the throttle in Run 5 or 6, the engine would stop.

To automatically reset the PC switch.

1. Close throttle to IDLE.
2. Place automatic brake valve in LAP.
3. Place foot on safety control foot pedal (if used).
4. Wait until application pipe builds up to normal pressure. Listen for exhaust or watch PC switch light. If, after an emergency application, the PC switch does not reset itself with the automatic brake in LAP, move the brake valve to RUNNING. The PC switch is set when the light goes out.
5. Reset train control (if used).
6. Place automatic brake valve in RUNNING.

303 **Engine Overspeed Trip** If the engine speed should exceed approximately 910 RPM, an overspeed device, Fig. 3-13, located on the front end of the engine will trip and stop the engine by preventing the injectors from injecting fuel into the cyl-

Engine Overspeed Trip
Fig. 3-13

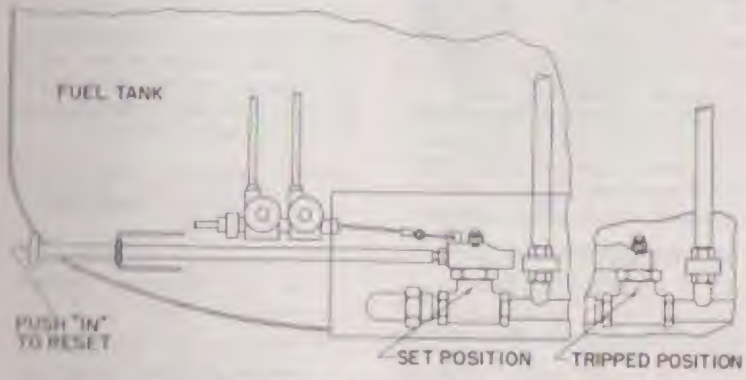
indera. The alarm bell and Blue light will come on if the engine is stopped in this manner while "on the line." The overspeed trip must be latched in the SET position before the engine can be restarted.

304 **Fuel Flow** For proper operation, a good flow of fuel (clear and free of air bubbles) should be indicated by the fuel return sight glass, Fig. 3-14, located on the sintered bronze filter assembly.

Fuel Sight Glasses
Fig. 3-14

If fuel is not flowing through return sight glass, check fuel pump motor. If motor is stopped, check (1) "Fuel Pump" circuit breaker in electrical cabinet must be ON, (2) "Control and Fuel Pump" circuit breaker must be ON, (3) Control knife switch and Main Battery Switch must be closed, and (4) for loose cable connections to motor. If pump is running but fuel is not pumped, check (1) fuel supply, (2) emergency fuel cutoff valve, (3) a suction leak in piping, (4) suction side of Dual Fuel filter (5) a slipping coupling at fuel pump.

305 **Emergency Fuel Cut-off Valve** Pulling any one of the three emergency fuel cut-off valve pull rings will shut off the fuel supply to the fuel pump (one is located on the rear cab



Emergency Fuel Cutoff Valve
Fig. 3-15

wall behind the engineer, and one on each side of the locomotive near the fuel tank filler cap).

This valve is located inside a compartment on the lower front center of fuel tank. Action of the valve is as shown in Fig. 3-15. To reset, push in on the valve yoke "push rod" extension which can be reached from the right side of the unit. Pushing in on this push rod as far forward as possible will reopen the valve.

306 **Control Air Pressure**

For the satisfactory operation of the pneumatically operated contactors and switches used in the control circuit, the electrical control air pressure gauge on rear wall of the cab must indicate 90 ± 3 lbs. The pressure regulator, Fig. 3-16, is located in the electrical cabinet. To raise or lower pressure, change adjustment on top of the regulator. A drain cock is provided on bottom of regulator for draining moisture.

Control Air Regulator Fig. 3-16

CORRECTION OF DIFFICULTIES

307 **If The Engine Goes to Idle**

1. Ground relay might be tripped.
2. No voltage relay (NVR), might be open (Blue light will be ON).
3. PC switch might be tripped.
4. "Control And Fuel Pump" circuit breaker on the engineman's control panel might be "Off."
5. "Engine Run" circuit breaker on the engineman's control panel might be "Off."
6. Isolation switch might be in START.

308 **If The Engine Stops**

1. Throttle might be in STOP position.
2. Low oil pressure button on the governor might be "out."
3. Engine overspeed device might have tripped.
4. No voltage relay (NVR) might have opened with throttle in RUN 5 or 6.
5. Ground relay might have tripped with the throttle in RUN 5 or 6.
6. "Engine Run" circuit breaker on the engineman's control panel might have been tripped "Off," with the throttle in Run 5 or 6.
7. PC switch might have tripped with the throttle in Run 5 or 6.
8. "Fuel Pump" circuit breaker in the electrical cabinet might be "Off."
9. "Control and Fuel Pump" circuit breaker on the control panel might be "Off."

10. Emergency fuel cutoff valve under the locomotive might be tripped.

300 **How To Start Engine** (If the engine has been stopped for a considerable period of time, the cylinders should be tested for fuel or water accumulation before starting the engine, see Art. 316.)

1. Place throttle in Idle and reverse lever in Neutral.
2. Place isolation switch in the START position.
3. Place the "Auxiliary Generator Field," "Alternator Field" and "Fuel Pump" circuit breakers in the electrical cabinet in the "ON" position.
4. Close all knife switches in the electrical cabinet.
5. At the engineman's control panel place the "Control And Fuel Pump" circuit breaker in "ON" position.
6. After allowing a few seconds for fuel to flow through the return sight glass, Fig. 3-14, solidly press the START button and hold until the engine starts, Fig. 3-17.

Starting Engine
Fig. 3-17

If engine fails to start after 15 seconds of rotation, check possible troubles listed under Arts. 310-311 before again trying to start engine.

7. After allowing time for the lube oil pressure to build up, place isolation switch in the RUN position.
8. Place "Engine Run" circuit breaker at engineman's control panel in ON position.

310 **If The Engine Does Not Rotate When "Start" Button is Pressed**

1. "Control And Fuel Pump" circuit breaker on the engineman's control panel must be ON.
2. Isolation switch must be in the START position.
3. 400-ampere starting fuse must be good.
4. Main battery switch and the Control knife switch in the electrical cabinet must be closed.

311 **If The Engine Rotates But Does Not Start When "Start" Button is Pressed**

1. Low oil pressure button on the governor must be pressed "IN."
2. Engine Overspeed trip must be "Set".
3. "Fuel Pump" circuit breaker in the electrical cabinet must be ON.
4. Emergency fuel cutoff valve must not be tripped.

5. See that fuel oil supply is adequate.

312 **If The Engine Does Not Speed Up When Throttle is Opened**

1. "Control and Fuel Pump" circuit breaker on the engineman's control panel must be ON.
2. "Engine Run" circuit breaker on engineman's control panel must be ON.
3. Isolation switch must be in RUN position.
4. PC switch must not be tripped.
5. Ground relay must not be tripped.
6. No voltage relay (NVR) must not be open.
7. Control knife switch in electrical cabinet must be closed.

313 **Engine Speeds Up But Locomotive Does Not Move When Throttle is Opened**

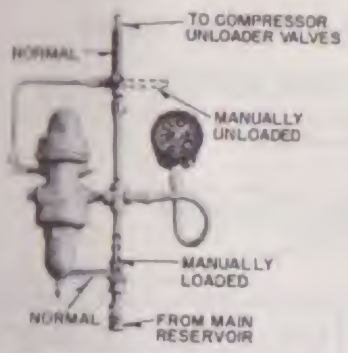
1. Reverse lever must be in either forward or reverse position.
2. Reverser drum switch must not be locked in neutral.
3. "Generator Field" circuit breaker must be ON.
4. There must 90 pounds (± 3 lbs.) control air pressure.
5. Selector lever must be in No. 1 position.
6. Hand brakes and air brakes must be released.
7. 80-ampere battery field fuse must be good.

314 **Battery Ammeter Shows Continual Discharge**
See Fig. 3-18.

1. Battery charging contactor located in the electrical cabinet must be closed.
2. 150 or 250-ampere auxiliary generator (battery charging) fuse must be good.
3. The "Auxiliary Generator Field" circuit breaker in the electrical cabinet must be ON.
4. The auxiliary generator knife switch in the electrical cabinet must be closed.

Battery Ammeter
Fig. 3-18

315 **Compressor Control** The air compressor is automatically governed and will normally keep the main reservoir pressure at 130-140 p.s.i. In case of trouble, the normal position of either of the valves, Fig. 3-19, may be changed as shown to manually load or unload the air compressor.



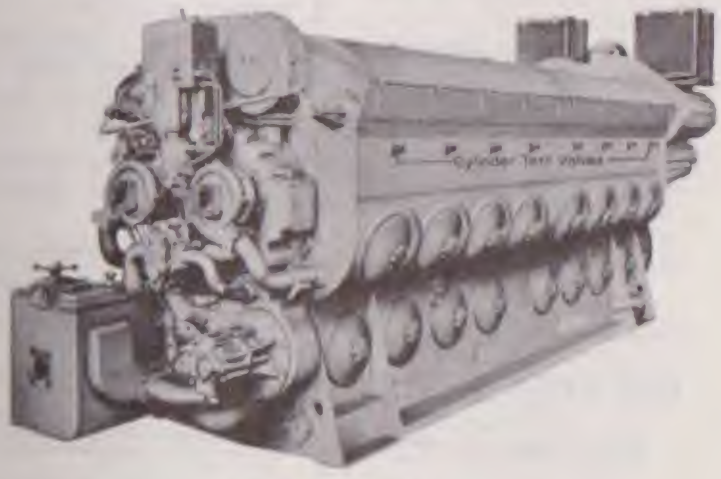
Compressor Unloader Valve
Fig. 3-19

316 **Cylinder Test Valves**

Each cylinder is equipped with a test valve, Fig. 3-20, for the purpose of testing for fuel or water accumulation in the cylinders prior to starting an engine that has been shut down for a considerable period of time.

To make this test, remove the 400-ampere starting fuse, open all cylinder test valves approximately 3 full turns, and use the engine jacking tool to rotate the engine one complete revolution. If liquid is discharged from any cylinder, investigate; if not, close cylinder test valves, replace 400-ampere starting fuse, and start engine in the usual manner.

If the engine is running and any cylinder test valve is heard to be leaking, the engine should be stopped, and the valve(s) should be tightened.



Cylinder Test Valves
Fig. 3-20

GP9 TROUBLE SHOOTING CHECK CHART

LOCOMOTIVE LOSES POWER (OR DOES NOT MOVE)

DIESEL ENGINE RUNNING

Engine Speeds Up When Throttle Is Opened

1. "Generator Fld." Sw. OFF
2. Reverse lever in Neutral
3. Reverser drum switch (in electrical cabinet) locked in Neutral
4. Selector lever in OFF position
5. Control air pressure low
6. 80 amp. batt. fld. fuse burned out
7. Brakes set

Engine Does Not Speed Up When Throttle Is Opened

1. Ground relay tripped
2. Isolation switch in Start
3. "Engine Run" switch OFF
4. "Control and Fuel Pump" switch OFF
5. "PCS" light ON
6. "NVR" light ON
   a. Auxiliary generator field switch OFF
   b. Alternator field switch OFF
   c. Auxiliary generator output fuse burned out
7. Control knife switch out
8. Loose governor cable

ADDITIONAL SAFETY DEVICES NOT AFFECTING LOCOMOTIVE LOSS OF POWER

Hot Engine Alarm

1. Cooling water level low
2. AC cooling fan contactors opened
3. Shutters not opened

Steam Boiler Stopped Alarm

1. Motor overload tripped
2. Stack switch tripped
3. Coil blowdown valve open
4. See Section 6

GP9 TROUBLE SHOOTING CHECK CHART

LOCOMOTIVE LOSES POWER (OR DOES NOT MOVE)

DIESEL ENGINE STOPPED

Causes Which Stop Engine Only In Throttle 5 and 6

1. Ground relay tripped
2. "NVR" de-energized
3. "PCS" actuated
4. "Engine Run" switch tripped open

Causes Which Stop Engine All Throttle Positions

1. Engine overspeed trip
2. Governor low oil button
3. Throttle in Stop position
4. Lack of fuel

Fuel Pump Motor Stopped

1. 30 amp. "Fuel Pump" switch OFF
2. "Control and Fuel Pump" switch OFF
3. "Control" knife switch OUT
4. Main battery switch OUT
5. Loose fuel pump cable

Fuel Pump Motor Running

1. No fuel supply
2. Emergency fuel "cutoff" tripped
3. Clogged suction filter
4. Clogged sintered bronze filters
5. Loose fuel pump coupling
6. Broken fuel suction line

SECTION 4

COOLING, LUBRICATING OIL, FUEL OIL AND AIR SYSTEMS

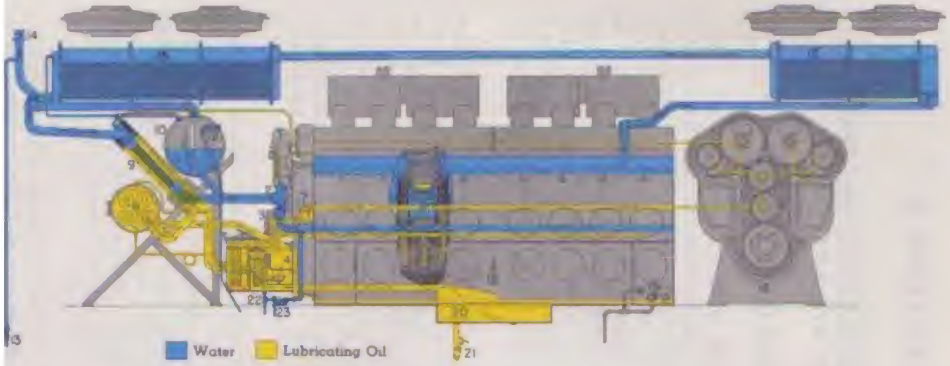
COOLING SYSTEM

A schematic flow diagram of the engine cooling system is shown in Fig. 4-1. Water is circulated through the cooling system by two centrifugal type pumps mounted on the front end of the engine. Water, drawn from the engine cooling water tank and oil cooler by the pumps, is forced through the engine and then through the radiator where it is cooled. After leaving the radiator, the water flows through the oil cooler and then to the suction side of the pumps where the cycle is repeated.

The radiator is made up of two banks; each bank consists of five radiator sections. Water leaving the engine and entering the radiator is divided between the right and left bank radiator sections. In each bank, two radiator sections are located at the cab end of the long hood, and three radiator sections are located at the opposite end of the long hood. The front and rear radiator sections of each bank are connected together by a water manifold.

Flow of cooling air through the finned radiator sections is controlled by shutters and four AC driven cooling fans. The operation of the fans and shutters is automatic (with the exception of one set of shutters adjacent to the cab which are manually controlled for cab heater operation). When the fans are operating, air flows up through the radiator sections and is discharged from the roof of the carbody.

The four AC driven cooling fans are mounted in the roof of the long hood above the radiator sections. Two fans control the cooling air through the cab end radiator



1. Engine Governor
2. Water Pumps
3. Lube Oil - Piston Cooling Pump
4. Scavenging Oil Pump
5. Sump Oil Strainer
6. Lube Oil Strainers
7. Lube Oil Relief Valve
8. Lube Oil Filter
9. Lube Oil Cooler
10. Cooling Water Tank
11. Water Level Gauge
12. "G" Valve
13. Water Tank - Side Filler
14. Water Tank - Roof Filler
15. Radiator
16. Camshaft Drive Gear Train
17. Engine Cylinder Liner
18. Engine Oil Pan Dipstick
19. Air Box Drain Valve
20. Engine Oil Sump
21. Oil Sump Drain Valve
22. Cooling Water Drain Valve
23. Steam Admission Valve

Fig. 4-1 - Schematic Of Cooling And Lube Oil Systems

sections of each bank and two fans mounted at the other end of the long hood control the cooling air through the rear banks of radiator sections. The fans are numbered one to four, beginning with the #1 fan located nearest to the cab end of the long hood.

Shutters are located on each side of the long hood just below the front and rear radiator banks. The shutters closest to the cab are manually controlled by levers located in the cab, one on each side of the electrical control cabinet. These shutters are used to control the cab temperatures and should normally be closed when the cab heaters are in operation. The shutters controlling the air flow through the #2 cooling fan are opened automatically by electro-pneumatic control when the #2 cooling fan is started. The shutters controlling the air flow through the #3 and #4 cooling fans are opened automatically when the #4 cooling fan is started.

A manual "cutout" switch to cut out the #1 cooling fan is located on the rear wall of the cab. The #1 cooling fan must be "cut out" when the cab heaters are in operation.

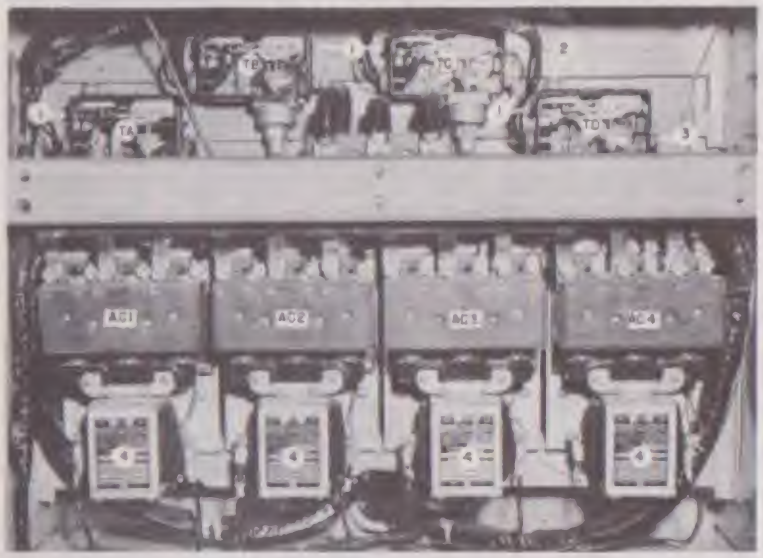
The operation of the cooling fans is controlled by temperature control switches, Fig. 4-2. The temperature control switches, set to close and open at various engine water temperatures, control the operation of the AC contactors. Closing of the AC contactor, starts the respective cooling fan. The temperature control switches are set to close the AC contactors as follows (the temperature control switch will open approximately 10^{o} F. below this setting):

AC1 - Closes at 165°F. (Fan will operate if #1 cooling fan cutout switch is "ON").

AC3 - Closes at 168°F.

AC4 - Closes at 171°F. - shutters controlling the air flow through the #3 and #4 fan also open.

AC2 - Closes at 180°F. - shutters controlling the air flow through the #2 fan also open.

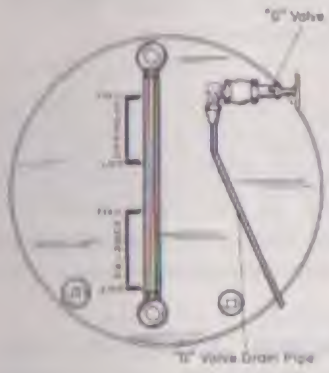


1. Engine Temperature Control Switch
2. Differential Adjustment
3. Range Adjustment
4. A.C. Fan Contactor

GP9 Engine Water Temperature Control
Fig. 4-2

400 **Operating Water Level** Operating water levels are stenciled on the water tank next to the water level sight glass to indicate minimum and maximum water levels with engine running and stopped. The engine should never be operated with the water below the low water level, Fig. 4-3. Progressive lowering of the water in the gauge glass indicates a water leak in the cooling system and should be reported.

401 **Filling Cooling System** The system is filled either through the filler pipe located on the roof of the locomotive above the water tank, or through the filler pipe on either side of the locomotive.



Cooling Water Levels
Fig. 4-3

To fill the system proceed as follows (Steps 5 to 8 are necessary only when filling a dry or nearly dry engine):

1. Stop engine.
2. Open "G" valve.
3. Fill slowly until water runs out the "G" valve drain pipe.
4. Close "G" valve.
5. Start engine and run several minutes. This will eliminate any air pockets in the system.
6. Stop engine and open "G" valve.
7. Add water until it runs out "G" valve drain pipe.
8. Close "G" valve.

If the cooling system of a hot engine has been drained, do not refill immediately with cold water. If this is done, the sudden change in temperature might crack or warp the cylinder liners and heads.

CAUTION: 1. Do not attempt to fill the cooling system through the drain pipe located underneath the locomotive.

2. The system should not be filled above the maximum water level indicated on the water tank to prevent:

a. Freezing of radiators in winter when engine is shut down.

b. Loss of rust inhibitor when draining back to "G" valve level.

402 **Draining Cooling System** The entire cooling system can be drained through the drain valve on the floor in front of the engine, with the exception of the water trapped in the water pump on the right hand side of the engine. To drain the right hand water pump, open the drain on the bottom of the water pump housing.

403 **Cab Heating and Ventilating** A cut-away of the GP9 cab heating and ventilating system is shown in the folded illustration on the reverse side of the wiring diagram at the end of the manual.

To operate the cab heating system place the #1 cooling fan cutout switch in the "OFF" position, and close the manually controlled shutters (move manual shutter control lever, one on each side of the electrical cabinet, to "closed" position).

Adjust the individual cab heater motor speed by turning the cab heater selector switch to one of its three operating positions: Low, Medium or Full as desired.

The outside air coming in through the #1 cooling fan roof opening is drawn through the radiator section adjacent to the cab by the cab heater blower. This heated air is forced into the cab through the cab heater inlet air duct. The cab heaters are independent of each other; one directing the flow of warm air to the firemen's side of the cab, the other directing the flow of warm air to the engineer's side of the cab. The cab air is recirculated by returning the air through the perforated cab ceiling return air duct to the radiator section adjacent to the cab.

The defroster is a simple non-adjustable baffle and duct arrangement directing the air supplied by the cab heater blower to the front and rear cab windows.

The temperature of the incoming air supplied by the cab heater blower, can be varied by (a) varying the speed of the cab heater motor and (b) by adjusting the opening of the manually operated shutters. Opening the shutters will allow cold outside air to be mixed with the heated air passing through the #1 radiator section.

To operate the cab ventilating system place the cab heater motor switches in "OFF" position.

Place the #1 cooling fan cutout switch in the "ON" position. (If the engine water temperature is 165° F. or higher, #1 cooling fan will start.)

With the #1 cooling fan in operation, the cab air is exhausted from the cab through the perforated cab ceiling return air duct. The amount of air being exhausted from the cab by the #1 cooling fan can be varied by varying the opening of the manually operated shutters. Maximum cab ventilation is obtained with these shutters closed.

LUBRICATING OIL SYSTEM

A schematic diagram of the lubricating oil system is shown in Fig. 4-1. Oil under pressure is forced through the engine for lubrication and piston cooling by the positive displacement combination piston cooling and lubricating oil pump. After circulating through the engine, the lubricating oil drains into the oil pan sump. The positive displacement scavenging oil pump draws oil from the sump and forces it through the filter and oil cooler. From the oil cooler, the oil is delivered to the oil strainer assembly where it is ready for recirculation by the combination piston cooling and lubricating oil pump. Since the scavenging oil pump delivers a greater quantity of oil to the strainer than is required

by the lubricating oil and piston cooling pump, the excess oil returns to the oil pan sump.

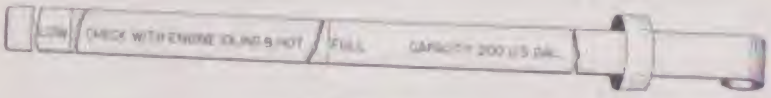
A relief valve is built into the filter in order to allow the passage of oil to the strainer in excess of the capacity of the oil filter elements.

A relief valve is also mounted on the left side of the accessory end of the engine. This valve is located in the discharge side of the lubricating oil pump. The purpose of this valve is to limit the maximum pressure of the lube oil entering the engine lube oil system to approximately 60 pounds.

Lube Oil Level
Fig. 4-4

404 **Oil Level** The oil level should be checked, Fig. 4-4, with the engine hot and running at idle speed. The dipstick should show a level between "Low" and "Full," Fig. 4-5. A "dipstick" is located on each side of the engine. When the engine is stopped, the oil in the filter and cooler will drain back into the oil pan. If the oil level is checked with the engine stopped, the reading on the "dipstick" will be above the "Full" mark.

405 **Adding Oil to System** Oil may be added with the engine running or stopped. When oil is added to



Oil Dipstick
Fig. 4-5

STRAINER DRAIN VALVE
Open ONLY If Draining
The Engine Oil Pan

Adding Oil To Engine
Fig. 4-6

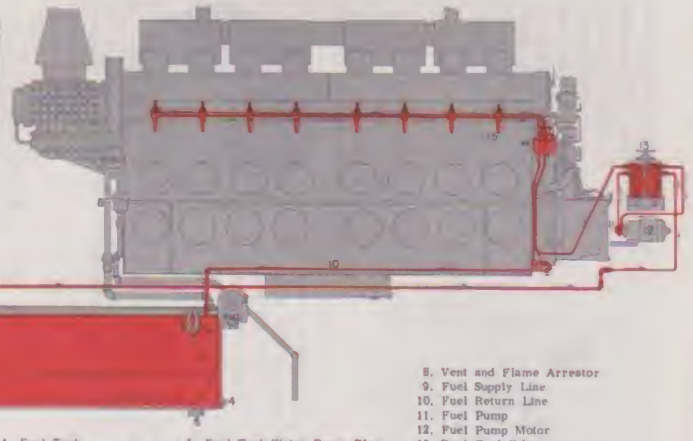
the system, it MUST be poured through the opening having the square cover, Fig. 4-6, on top of the housing. Should the round caps be removed while engine is running, hot oil under pressure will come from the openings and possibly cause personal injury.

406 **Oil Pressure** A lubricating oil pressure gauge, Fig. 4-7, is mounted on the equipment stand supporting the oil cooler and Michiana filter assembly. Oil pressure at 835 RPM is normally 40 to 50 pounds. It should not drop below 20 pounds. At IDLE, the pressure should be at least 6 pounds. In the event of dangerously low oil pressure the engine will automatically be stopped by action of the governor low oil pressure button.

Oil Pressure Gauge
Fig. 4-7

FUEL OIL SYSTEM

A schematic diagram of the fuel oil system is shown in Fig. 4-8. Fuel is drawn from the storage tank through the suction side of the dual fuel filter by the motor driven gear type fuel pump. From the pump the fuel is forced consecutively through the pressure side of the dual fuel filter and the sintered bronze filter. After passing through the double element sintered bronze



1. Fuel Tank
2. Fuel Filler
3. Fuel Fill Sight Glass
4. Fuel Drain Plug
5. Fuel Tank Water Drain Plug
6. Emergency Fuel Cutoff Valve
7. Emergency Fuel Cutoff Valve Pull Ring
8. Vent and Flame Arrestor
9. Fuel Supply Line
10. Fuel Return Line
11. Fuel Pump
12. Fuel Pump Motor
13. Dual Fuel Filter
14. Sintered Bronze Filter and Sight Glass Assembly
15. Injector

Schematic Of Fuel Oil System

Fig. 8

filter the fuel flows to the injectors. The excess fuel not used by the injectors returns to the fuel tank through the return fuel sight glass, mounted on the sintered bronze filter housing. An orifice restricts the flow of fuel into the glass and causes a slight back pressure of fuel on the injectors. By maintaining a slight back pressure on the injectors a positive supply of fuel for the injectors is assured.

The fuel pump delivers more fuel to the engine than is burned in the cylinders. The excess fuel circulated through the injectors is used for cooling and lubricating the fine working parts of the injectors.

A 15 pound relief valve is built around the pressure side of the dual fuel filter. This relief valve bypasses fuel to the sintered bronze filter if the element in the pressure side of the dual filter becomes clogged.

407 **Fuel Sight Glasses** Mounted on the sintered bronze filter housing are two sight glasses, Fig. 4-9.

For proper engine operation, a good flow of fuel (clear and free of bubbles) should be indicated in the sight glass nearest the engine called the "fuel return sight glass." With no fuel showing in the fuel return sight glass, check to see that fuel pump motor is running. If motor is running and no fuel is flowing in return sight glass, check (a) fuel supply in fuel tank (b) position of emergency fuel cutoff valve (c) clogged suction filter (d) suction leak

Sight Glasses
Fig. 4-9

in piping between tank and pump or (e) broken or slipping coupling at fuel pump.

If fuel pump motor is stopped, check (a) "Control and Fuel Pump" circuit breaker must be "ON" (b) "Fuel Pump" circuit breaker in electrical cabinet must be "ON" (c) control knife switch must be closed (d) main battery switch must be closed or (e) loose fuel pump motor cable connection.

The sintered bronze filter is also equipped with a 45-pound relief valve and sight glass, Fig. 4-9. This sight glass is referred to as the "45-pound sight glass" and is normally empty. When more than a trickle of fuel is seen in the 45-pound sight glass, it indicates that the relief valve is open. Fuel will pass through the 45-pound sight glass and relief valve to by-pass the engine and return to the fuel tank in case the sintered bronze filter becomes clogged.

408 **Filling Fuel Tanks** The fuel tank can be filled from either side of the locomotive. A short sight level gauge is located next to each fuel filler. This fuel gauge indicates the fuel level from the top to about 4-1/2" below the top of the tank and should be observed while filling the tank to prevent overfilling. DO NOT HANDLE FUEL OIL NEAR AN OPEN FLAME.

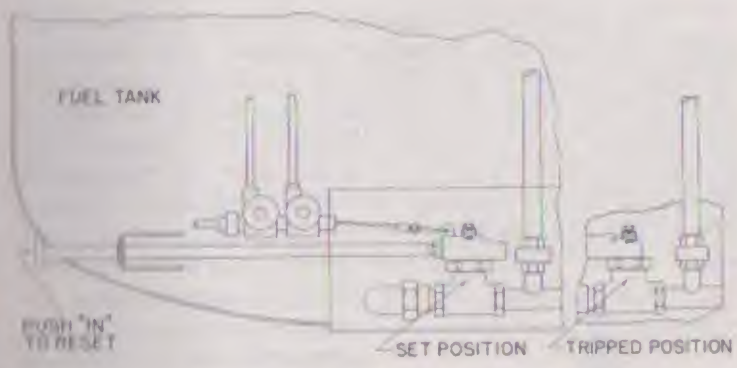
409 **Fuel Gauge** The basic fuel capacity is 800 gallons. Full length sight level gauges are located on each side of the front end of the fuel tank. These gauges indicate the level of fuel in the tank below the low level of the short fuel filler gauge.

410 **Emergency Fuel Cutoff Valve** An "Emergency Fuel Cutoff Valve," Fig. 4-10, is provided to cut off the fuel supply to the fuel pump in the event of fire, or any emergency. It is located inside a compartment on the lower front center of the fuel tank. On each side

of the locomotive is a small box with a lift cover. Enclosed in this box is a pull ring on the end of the cable running to the fuel cutoff valve. A similar ring is located in the cab of the locomotive.

The fuel cutoff valve can be tripped by pulling any one of these three rings. If tripped, the valve must be reset manually.

To reset the valve, "push in" on the rod extending from the valve compartment on the right side of the locomotive.



Emergency Fuel Cutoff Valve
Fig. 4-10

AIR SYSTEM

Compressed air is not only used on a Diesel locomotive for operating the air brakes and sanders but is also essential for the proper operation of many other items. The reverser switch, main power contactors, shutter operating cylinder, horn, bell and windshield wipers are also air operated. Some of the items mentioned are merely electro-pneumatic valves. This means that in such cases the flow of air, through the valve, is controlled by electrical circuits.

411 **Air Compressor** Each locomotive power plant is basically equipped with an air cooled 3-cylinder, two stage air compressor, Fig. 4-11. The air compressor is driven through a flexible coupling, from the front end of the engine crankshaft.

The compressor has its own oil pump and pressure lubricating oil system. With the engine stopped the oil level in the compressor crankcase can be checked on the bayonet type gauge. At idle speed (275 RPM) with the compressor crankcase oil hot, the lubricating oil pressure should be approximately 15 to 20 pounds.

The compressor consists of two low pressure cylinders and one high pressure cylinder. The pistons of all three cylinders are driven by a common crankshaft. The two low pressure cylinders are set at an angle to the vertical high pressure cylinder. Air from the low pressure cylinder goes to an intercooler, or radiator to be cooled before entering the high pressure cylinder. The intercooler is provided with a pressure gauge and relief valve. The gauge normally reads approximately 45 to 50 pounds when the compressor is loaded. The intercooler relief valve is set for 65 pounds. Any marked deviation of intercooler pressure from 45 to 50 pounds should be reported at the maintenance terminal.

Air Compressor
Fig. 4-11

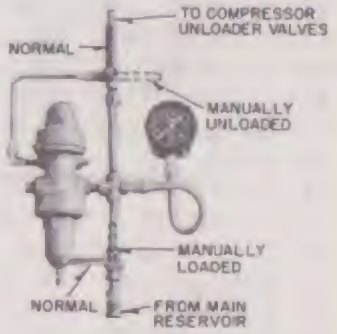
An oil separator, in the discharge air line from the high pressure cylinder, filters oil droplets and carbon particles out of the air. A drain valve is provided to drain the oil separator and should be drained once

at each crew change and at regular maintenance period. It is also recommended to drain the compressor intercooler (two drain valves are provided in the bottom header) and the main reservoirs when draining the compressor oil separator, to prevent moisture and dirt from being carried into the air brake and electrical control air systems.

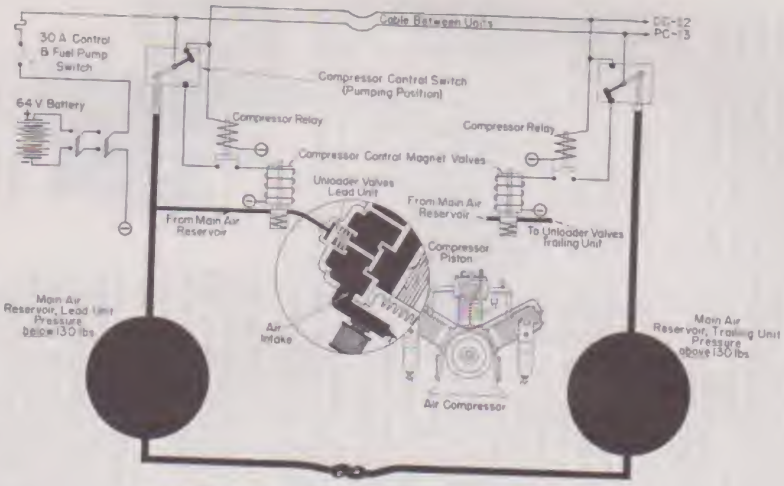
412 **Compressor Control** Since the air compressor is directly connected to the engine, the compressor is in continuous operation (although not always pumping air) whenever the engine is running. An unloader piston is provided in the head of each high and low pressure cylinder which cuts out the compressing action when actuated by air pressure from the compressor governor control. The unloader accomplishes this by blocking open the intake valves of the high and low pressure cylinders. When the air operating the unloader is cut off, the unloader releases the intake valves and the compressor resumes pumping. Main reservoir air pressure is used to actuate the unloader valves.

Two methods of compressor governor control are used: (1) Pneumatic governor control and (2) Electropneumatic governor control.

On locomotives with the pneumatic governor control system, Fig. 4-12, each air compressor operates as an individual component without regard to the main reservoir demands of other units in the consist. When the main reservoir air pressure reaches 140 pounds, the governor "cuts out" the air compressor by admitting air to unloader valves. Admitting air to the unloader



Pneumatic Governor Control System
Fig. 4-12



Electro-Pneumatic Governor Control System
Fig. 4-13

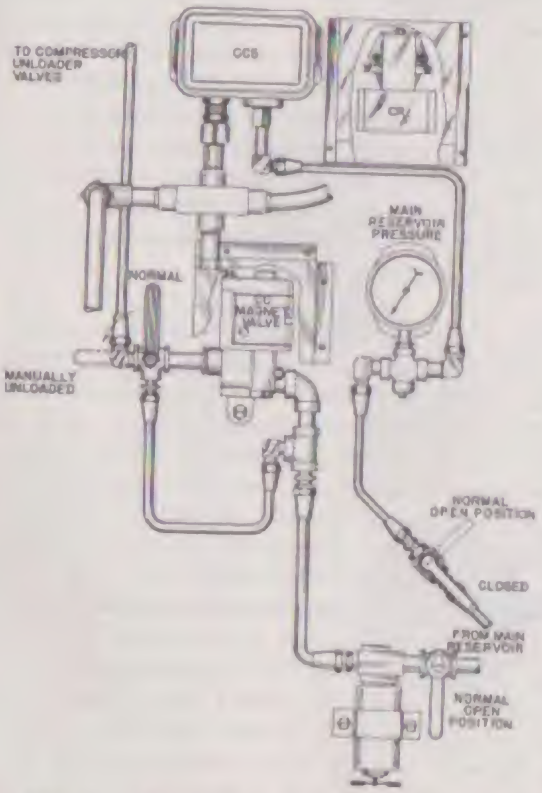
valve will hold the intake valves open stopping the compressing action. The compressor remains unloaded until the main reservoir pressure falls to 130 pounds. The governor then "cuts in" the air compressor by stopping the air supply to the unloader valves, releasing the intake valves and the compressor resumes pumping.

If all the units of a locomotive consist are equipped with the electro-pneumatic system of compressor governor control, Fig. 4-13, the electrical arrangement is such that all compressors in the locomotive are synchronized to pump air into their respective main reservoirs when the main reservoir pressure in any one unit drops to 130 pounds. When the air pressure in all reservoirs reaches 140 pounds, the compressors will unload. Each unit is equipped with a compressor control switch (CCS) actuated by main reservoir pressure, a compressor control magnet valve and a compressor relay (CR). A compressor control wire (CC) runs throughout the locomotive and connects the compressor relays in each unit in parallel.

This electro-pneumatic governor control is located on the equipment rack supporting the water supply tank, oil cooler and Michiana filter assemblies, Fig. 4-14. The compressor control switch may be considered to be a single-pole double-throw switch that is thrown to the "loaded" position when the main reservoir pressure drops to 130 pounds, or to the "unloaded" position when the main reservoir pressure reaches 140 pounds. In the unloaded position the CCS causes the compressor control magnet valve to be energized, allowing air to pass through the valve to the compressor unloader pistons stopping the compressing action. In the loaded position the CCS breaks the circuit to compressor control magnet valve in that unit and causes current to flow through the CC wire energizing the CR relays in each unit. When the CR relay is energized its interlock breaks the circuit to the compressor control magnet valve regardless of the position of the CCS in that

unit. Breaking the circuit to the compressor control magnet valve shuts off the supply of air to the compressor unloader pistons, and the compressor resumes pumping.

413 **Manual Unloader Valve** A three-way valve, Fig. 4-12 or Fig. 4-14, is provided in case it is desired to keep an air compressor unloaded, irrespective of the compressor control system. A raised "T"



Electro-Pneumatic Governor Control
Fig. 4-14

pattern on the face of the valve indicates the flow of air through the valve. The valve is normally positioned so as to direct the air supply to the unloader valves through the compressor governor control. To manually unload the air compressor, turn valve to bypass main reservoir air supply to the unloader valves around the compressor governor control.

414 **Draining of Air System** The air system should be drained periodically to prevent moisture from being carried into the air brake and electrical control air systems. The frequency of draining will depend on local conditions and can be determined by practice. It is recommended that d r a i n i n g be done at the time of each crew change, until a definite schedule can be determined by the individual railroad.

SECTION 5

ELECTRICAL EQUIPMENT

500 **Basic Electrical Systems** In full throttle, the rated horsepower of the engine is delivered to the direct coupled main generator. At the main generator the power of the engine is transformed into electrical power. The electrical power is then conducted to the four traction motors, two motors being located in each truck (each motor being geared to an axle).

The locomotive is designed so that within the current and voltage limits of the main generator, the power (KW) delivered to the traction motors at full throttle, is the same, regardless of the locomotive's speed.

The electrical system of the locomotive can be thought of as being divided into three separate systems:

1. High voltage system.
2. Low voltage system.
3. Alternating current system.

The high voltage system is directly concerned with moving the locomotive; or in retarding the locomotive when dynamic braking is used. The main components of the high voltage system are the main generator, traction motors, forward and backward transition relays, shunt field contactor, motor shunting contactors, reverser drum, wheel slip relays, ground relay, series and parallel power contactors. On locomotives equipped with dynamic brakes, the brake transfer switches (camswitch), brake grids and brake grid blower motors may also be considered as part of the high voltage system.

The low voltage system contains the control circuits which control the flow of power in the high voltage

system, and those auxiliary circuits conducting power to the locomotive lights, heater fans, fuel pump and the main generator battery field. A 64 volt battery, in the low voltage system, is the source from which power is taken to start the Diesel engine. Once the engine is started, the auxiliary generator takes over the job of supplying power to the low voltage system.

The alternating current system includes an alternating current generator (called an alternator), four engine cooling fan motors, and four traction motor blower motors. The alternating current system provides a means of driving accessories, without the use of belt drives, at speeds which vary according to the speed of the engine.

501 **Main Generator** The main generator is a specially designed constant kilowatt (power) generator. A given amount of electrical power will be produced from the input of a given amount of mechanical power. Since power in watts is the product of volts times amperes it is seen that with a constant kilowatt generator, if the volts increase the amperage decreases, and vice versa.

Main generator voltage is nominally 600 volts but this varies with operating conditions. The output voltage of the main generator is controlled by the extent to which the main generator is automatically excited and the speed of the engine.

The main generator contains six field windings: starting, battery, shunt, differential, compensating and commutating. The starting field is used only when the main generator is used as a starting motor to rotate the engine. With regard to locomotive operation, the shunt and battery fields provide the major excitation of the main generator.

The battery field provides the initial excitation of the main generator and is a low voltage, externally excited field. The current flowing through the battery field is varied by the action of the load regulator. By varying the strength of the battery field, the power output of the main generator is largely controlled.

The main generator is self-excited by the shunt field. The shunt field is a high voltage field whose excitation varies with the voltage of the main generator. A shunt field contactor opens or closes the circuit to the shunt field.

The differential, compensating and commutating fields are permanently connected and are a matter of engineering design providing desired generator characteristics and proper commutation.

502 **Traction Motors** The traction motors are direct current, series wound motors geared to the driving axles. The motors are reversed by changing the direction of current flow in the field windings, the direction of current flow in the armature always being the same. A reverser drum operated by electro-pneumatic control reverses the current flow in the traction motor field windings.

The traction motors are cooled by alternating current driven blowers, one for each motor. The traction motor blowers are mounted on the floor of the engine-room and blow air through flexible ducts to the traction motors. The speed of the blowers varies with the speed of the engine; this is due to the engine speed varying the frequency of the alternator.

The maximum permissible top speed of the locomotive is limited by the safe RPM of the traction motor armature; thus a high speed gear ratio is required for

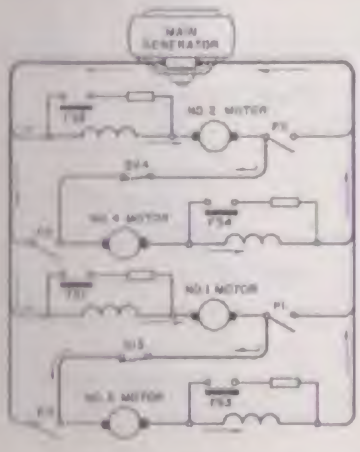
high speed train operation. A low speed gear ratio is needed to start and use full horsepower with low speed tonnage trains without overheating and damaging the electrical equipment.

503 **Reversing Locomotive** Movement of the reverse lever to the forward or reverse position energizes the respective FOR or REV magnet-valves on the reverser, located in the electrical cabinet, Fig. 5-1. When either of the magnet valves is energized it allows control air to pass through the valve, moving the reverser to the desired direction (with four long segments showing on reverser drum, the reverser is in forward; eight short segments can be seen when in the reverse position).

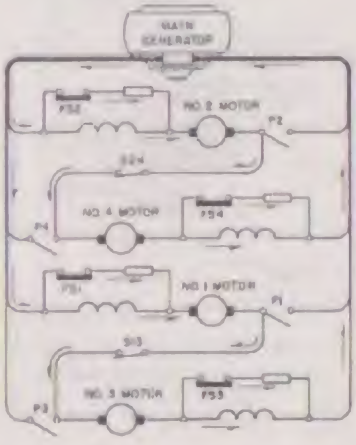
Reverser Switch
Locked in Neutral
Fig. 5-1

504 **Transition** This term is applied to the changing of traction motor electrical connections on all Diesel-electric locomotives so that full power may be obtained from the main generator within the range of its current and voltage limits. To look at it another way, transition is a method of adjusting the traction motor "back pressure" (counter-e.m.f.) bucking the input of power from the main generator so that this back pressure will not become too high at higher speeds nor too low at lower speeds.

Standing still the traction motors have practically no "back pressure," or resistance to the input of current from the main generator. However, as the locomotive speed increases after starting in series-parallel (transition 1), Fig. 5-2A, the "back pressure" of the traction motors builds up and causes the main generator "pressure" (voltage) to increase so that it can continue forcing current into the motors. Although the main generator can vary its voltage over a wide range, there is a practical operating limit to its ability to increase its voltage. If this practical voltage limit were exceeded, the power output of the main generator, and correspondingly the engine, would drop off. To prevent this loss of power, a change is made in the electrical circuit just before the drop off begins (the main generator at this time will have reached approximately 965 volts). The first change, Fig. 5-2B, from transition 1 to 2 (series-parallel shunt) connects a by-pass (shunt) circuit around each of the traction motor fields. Shunting the traction motor fields effects a reduction in the "back pressure" of the traction motors, which in turn allows the voltage in the main generator to reduce itself



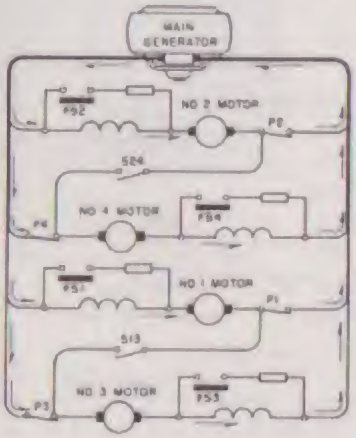
Series-Parallel
Fig. 5-2A



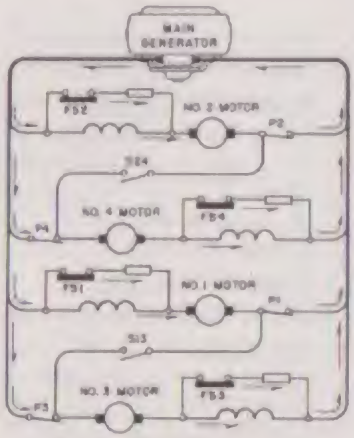
Series-Parallel Shunt
Fig. 5-2B

(with a constant KW generator, as the voltage goes down the amperage goes up, and vice versa). Thus, by shifting to transition 2 more current can pass through the traction motor armatures to maintain the full power output of the locomotive.

As the locomotive speed increases there is again a tendency for the power to drop off. This time, when the main generator reaches approximately 965 volts, a complete change in the electrical circuit is necessary to once again reduce the "back pressure" of the traction motors. When this change from transition 2 to 3 (parallel), Fig. 5-3A, is completed, the main generator continues the full application of power until a still higher locomotive speed is reached. At this time, when the voltage returns up to approximately 965 volts, the motor shunting contactors are again closed (once again reducing the traction motor "back pressure") effecting transition from 3 to 4 (parallel shunt), Fig. 5-3B. With decreasing speeds, as caused by grades, a reverse sequence of transition takes place to prevent exceeding the current limitations of the main generator.



Parallel
Fig. 5-3A

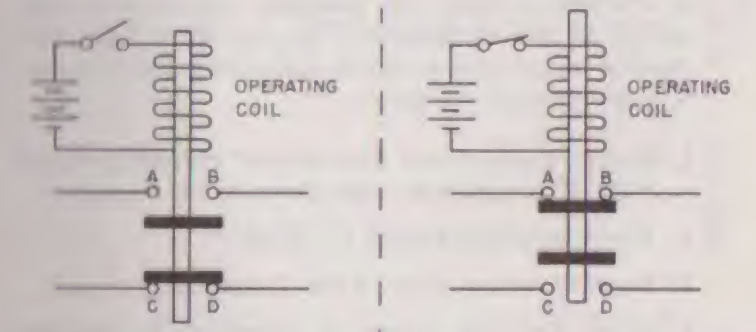


Parallel Shunt
Fig. 5-3B

505 **Transition Control Circuit** Three relays (FSR, FTR and BTR) actuate the changing of traction motor connections in the fully automatic forward and backward transition.

The FSR and FTR are voltage operated relays, whereas the BTR is a current operated device. Forward transition is always made at a predetermined main generator voltage. Backward transition is made at a predetermined main generator voltage from the shunting position (4 to 3 and 2 to 1) by the dropping out of FSR. Backward transition from the parallel position is made at a predetermined main generator amperage by the picking up of the BTR.

A relay, or contactor, as used on a Diesel locomotive, consists of an operating coil, a set of main contacts and/or several auxiliary contacts called interlocks. The interlocks can be normally open or closed with the operating coil de-energized (dropped out). Energizing (picking up) the coil will change the normal position of the relay interlocks. See Fig. 5-4.



NO POWER APPLIED TO COIL

COIL IS DE-ENERGIZED (DROPPED OUT)
INTERLOCK AB IS NORMALLY OPEN
INTERLOCK CD IS NORMALLY CLOSED

WITH POWER APPLIED TO COIL

COIL IS NOW ENERGIZED (PICKED UP)
INTERLOCK POSITION CHANGE:
AB IS NOW CLOSED
CD IS NOW OPENED

Operation Of Interlocks
Fig. 5-4

Thus, an interlock shown on the wiring diagram in a closed position will open when its respective operating coil becomes energized (Example: $P1_{ab}$ interlock normally closed will open when the P1 contactor operating coil is energized).

When the coil is de-energized (drops out) the interlock returns to its normally closed position.

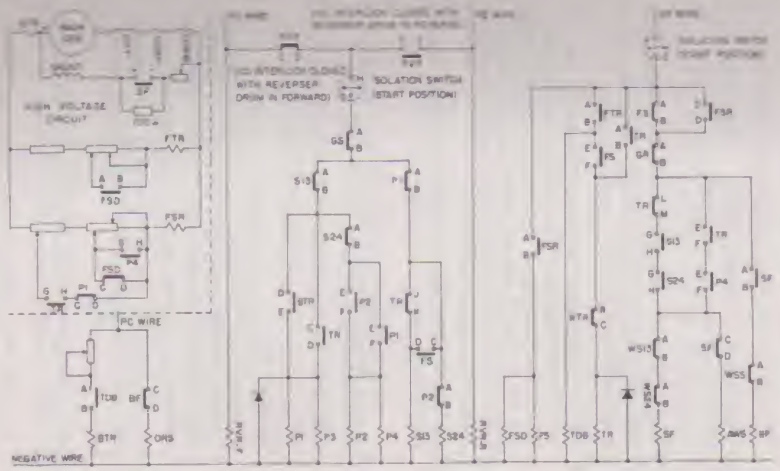
Similarly, an interlock shown on the wiring diagram in an open position will close when its respective operating coil becomes energized (picks up). When the coil is de-energized (drops out) the interlock will return to its normally open position.

Fig. 5-5 is a schematic diagram of the transition control circuit. The change in traction motor connections takes place as follows:

Series-Parallel (Transition 1)

In starting a train, the traction motors are connected in series-parallel. To connect the traction motors in series-parallel and move the locomotive, proceed as follows:

1. Place "Control and Fuel Pump" circuit breaker "ON" (Current now flows through PC wire).
2. Place Isolation switch in "RUN."
3. Move selector lever to No. 1 position.
4. Move reverse lever to forward or reverse (Current now flows through the FO or RE wire, depending on position of reverse lever).
5. S13 and S24 contactors close (Traction motors connected in series-parallel).
6. Place "Engine Run" circuit breaker "ON."
7. Place "Generator Field" circuit breaker "ON."



Schematic Of Automatic Transition Circuit
Fig. 5-5

8. Open throttle to run position 1 or higher (Current now flows through GF wire).
9. SF and BF contactors close (Locomotive moves).

As train speed increases, throttle in Run 8 position, automatic forward transtion takes place as follows:

Series-Parallel to Series-Parallel Shunt (Transition 1-2)

1. FSR picks up at approximately 965 volts (Current flow through FSD_{cd} picks up FSR).
2. FSD is energized (FSD is a time delay relay set to delay the opening of its normally closed interlock CD and closing of its normally open interlock AB for 10 to 12 seconds after the FSD is energized. This action prevents a sudden backward transition change from 2-1).
3. FS closes (Change to series-parallel shunt completed).

Series-Parallel Shunt To Parallel (Transition 2-3)

1. FTR picks up at approximately 965 volts (current flow through FSD_{ab} picks up FTR).
2. TR picks up.
3. TDB picks up (TDB picking up increases the pick-up value of BTR from 2250 $\pm$ 25 amperes to 2400 - 2500 amperes, for approximately three minutes, preventing a sudden backward transition 3-1).
4. SF and BF drop out (SF dropping out, inserts additional 100 ohms in SF circuit, decaying generator gradually).
5. ORS is energized (Load Regulator moves toward minimum field).
6. TR_{gh} with PI_{cd} lower dropout value of FSR to approximately 515 volts.
7. FTR drops out.

8. FSR drops out (approximately 515 volts).
9. FS opens.
10. FSD is de-energized.
11. TDB drops out (TDB is a time delay relay set to hold its normally open interlock TDB_{ab} closed for approximately 3 minutes after the operating coil is de-energized. This action prevents a sudden backward transition change from 3 to 1).
12. S13 drops out.
13. P1 and P3 pick up.
14. S24 drops out.
15. P2 and P4 pick up.
16. SF and BF pick up.
17. ORS is de-energized (Transition change to parallel is completed; locomotive resumes power).

Parallel To Parallel Shunt (Transition 3-4)

1. FSR picks up at approximately 965 volts (Current flow through $P4_{gh}$ picks up FSR).
2. FSD is energized.
3. FS closes (Change to parallel shunt completed).

As train speed decreases, throttle in Run 8 position, automatic backward transition takes place as follows:

Parallel Shunt to Parallel (Transition 4-3)

1. FSR drops out (approximately 670 volts - inherent dropout).
2. SF and BF drop out.
3. FSD is de-energized.
4. FS opens.
5. SF and BF pick up (Backward transition change to parallel completed; locomotive resumes power).

Parallel to Series-Parallel to Series-Parallel Shunt (Transition 3-1-2)

1. BTR picks up (2250 ± 25 amperes).
2. TR drops out.
3. SF and BF drop out.
4. ORS is energized (Load Regulator moves toward minimum field).
5. BTR drops out (drop out value is approximately 83% of pickup value - BTR drops out due to decaying main generator fields with SF and BF open).
6. P1 and P3 drop out.
7. S13 picks up.
8. P2 and P4 drop out.
9. S24 picks up.
10. SF and BF pick up.
11. ORS is de-energized (Backward transition change to series-parallel is now completed and locomotive resumes power).
12. Main generator voltage following backward transition from parallel to series-parallel (3-1) will reach approximately 965 volts in a few seconds and forward transition from 1-2 will take place.

FSR is adjusted automatically to drop out at approximately 745 volts in series-parallel shunt. Backward transition from 2-1 will take place when this voltage is reached.

506 **Load Regulator** Essentially the load regulator is an automatically operated rheostat connected in series with the battery field of the main generator.

The load regulator is a self-contained unit which consists of a hydraulic vane type motor connected to a

commutator type rheostat, Fig. 5-6. Engine oil pressure is used to force the vane motor (and rheostat brush-arm) to vary its position. Oil pressure is impressed on either side of the vane, as directed by the load regulator pilot valve, which is located in the engine governor.

For the purpose of load regulation, engine horsepower is determined by the rate of fuel consumption; this merely means that more horsepower is developed when more fuel is used, and vice versa. There is a definite rate of fuel consumption for each throttle position when the engine is loaded. The rate of fuel consumption is related to the position of the governor power piston, which controls the opening of the injector racks. If the load on the engine should be such that more fuel is demanded (to rotate the engine at the RPM "ordered" by the throttle) than the predetermined balance point (between load and fuel consumption), the load regulator pilot valve will cause the load regulator to reduce the engine load the required amount by reducing the battery field strength.

Load Regulator
Fig. 5-6

If the engine requires less fuel than the predetermined setting, the load regulator increases the load on the engine by increasing the battery field excitation of the main generator. In this manner, battery voltage, temperature changes in the generator windings, or locomotive speeds do not cause overloading or underloading of the engine and a constant power output is maintained for each throttle setting.

Located in the governor is an over-riding solenoid, ORS, which can over-ride the normal action of the load

regulator pilot valve. When the ORS is energized it forces the load regulator pilot valve to cause engine oil pressure to move the load regulator toward the minimum field position unloading the engine. The ORS is energized during transition and wheel slip action.

The governor is also equipped with two microswitches, LRS and OLS, which protect against possible engine overload. The switches are set to close when a pre-determined high rate of fuel consumption is reached. When the LRS switch closes, the "quick starting" feature of the GP9 is cut out, and the control of engine loading is returned to the load regulator. (The "quick starting" feature is effective only in transition 1). When the OLS switch closes, the ORS is energized moving the load regulator toward the minimum field position, reducing the load on the engine.

507 **Engine Speed Control** The throttle lever, in the controller, has ten positions: STOP, IDLE and RUNNING SPEEDS 1 THROUGH 8. Each throttle step, from 2 through 8, increases the engine speed 80 RPM.

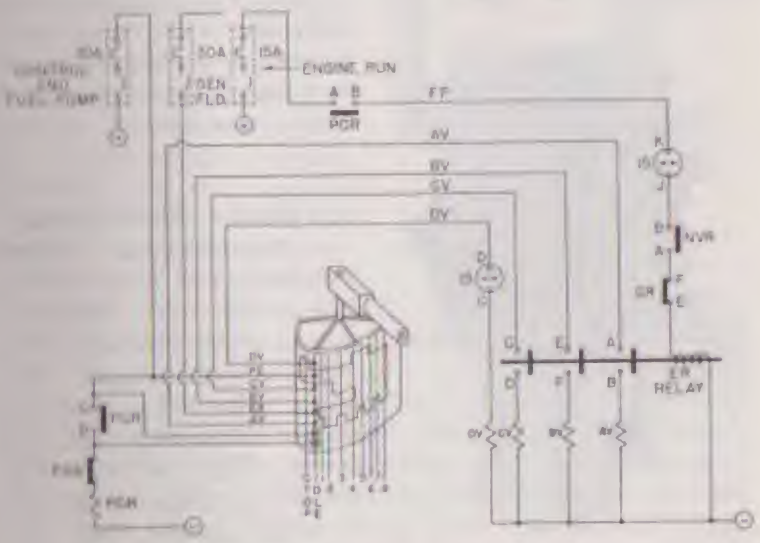
The throttle lever operates a drum type switch which distributes current from a "hot wire" to one or more other wires, depending on the position of the throttle.

The governor is designed so that the energizing of various combinations of four governor solenoids (AV, BV, CV, and DV) causes the engine to respond to the "orders" of the throttle. The "ENGINE SPEED CHART" shows the various combinations of solenoids that are energized to obtain the desired engine speeds for the various throttle positions. The Engine Speed Control schematic diagram, Fig. 5-7, shows the method of energizing the various governor solenoids for the various positions of the throttle.

508 **ER Relay** The ER relay controls the current supply to the A, B, and C governor control solenoids. De-energizing this relay will cause the

ENGINE SPEED CHART

Throttle Position	Governor Solenoids Energized A	B	C	D	Engine Speed RPM
STOP				•	0
IDLE					275
1					275
2	•				355
3			•		435
4	•		•		515
5		•	•	•	595
6	•	•	•	•	675
7		•	•		755
8	•	•	•		835
Effect of Solenoids on Engine RPM	+80	+320	+160	-160 (or stop)	

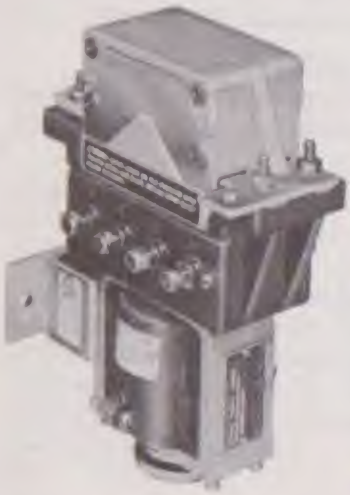


Engine Speed Control
Fig. 5-7

engine to immediately stop if the throttle is in Run 5 or 6. De-energizing the ER relay in any other throttle position will bring the engine to idle.

To control the engine speed in any unit the ER relay in that unit must be energized. The ER relay has three normally open interlocks which will close, when the relay is energized, to connect the control circuits to the A, B, and C governor control solenoids, Fig. 5-7. The ER relay has no control of the D governor control solenoid.

The ER relay in each unit is energized by current received from the FP wire that runs throughout the locomotive. The "Engine Run" circuit breaker at the engineman's control panel must be ON to energize the FP wire. The main battery and control knife switches must also be closed. For current to flow through the FP wire to the ER relay: the "Engine Run" circuit breaker at the engineman's control panel must be ON, the "PC" switch must be closed, the isolation switch must be in RUN, the NVR relay must be energized (engine must be running), and the Ground Relay must be set.



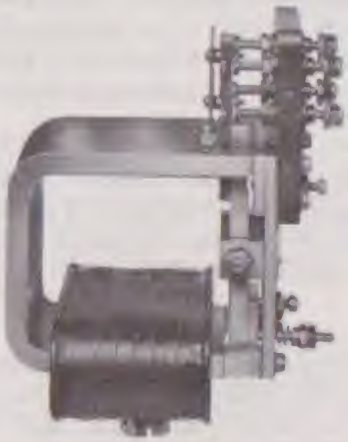
Battery Field Contactor
Fig. 5-8

509 **Battery Field Contactor and Fuse** When the throttle is moved from Idle to Run 1 this contactor closes, and connects low voltage excitation to the main generator battery field. The battery field contactor, Fig. 5-8, remains closed as long as power is being applied, but will open during transition and wheel slip action. A rectifier and discharge resistor

are used to dissipate the high voltage induced in the battery field when the battery field contactor is opened.

An 80 ampere battery field fuse located in the electrical cabinet protects the battery field circuit. If the fuse is blown the locomotive will not develop normal power.

510 **Wheel Slip Control** The wheel slip control system goes into operation the moment that the slipping of a pair of wheels is detected while under power. Located in the electrical cabinet are four wheel slip control relays, WS13, WS24, WSS and WCR. Each relay is of the through-cable type, Fig. 5-9.



Wheel Slip Relay
Fig. 5-9

The WS13-24 relays are operated by two sources; (1) By a flow of current through the relay coil with the traction motors connected in series-parallel or series-parallel shunt. Current will flow through the relay coil when an unbalance in the bridge circuit between two 2000 ohm resistors and two traction motors, which the relay coil bridges, occurs as a result of a "slipping" motor. (2) By a current differential between the cables that pass through the relay frame with the traction motors connected in parallel or parallel-shunt. These cables are so arranged that the normal current flow through them is of equal magnitude and in opposite directions. Thus, the magnetic field established by the current flow in one cable is nullified by the magnetic field established by the current flow in the second cable. When an unbalance in the current flows occurs as a result of

a "slipping" motor, the resultant magnetic field established actuates the WS relay.

The WCR (wheel creep relay) and WSS (wheel slip series) are operated only by a current differential between the cables that pass through the relay frame, with the traction motors connected in series-parallel or series-parallel shunt.

Automatic sanding in power occurs through the action of the WCR relay. The WCR is used to detect very slow creeping type slips. The function of the WCR, having a slightly lower pickup value than the WSS and WS relays, is to automatically apply sand to the rails which tends to prevent a wheel slippage necessitating the reduction of generator field excitation.

When WCR picks up, it energizes the time delay sanding relay (TDS). "Picking up" of the TDS automatically actuates the forward or reverse sanding valves, depending on the position of the reverse lever, applying sand to the rail.

At very slow speeds, if the wheel slip cannot be corrected through the action of the WCR applying sand to the rails, the WSS picks up to reduce main generator excitation. When the WSS picks up, the wheel slip light will flash ON and the battery field contactor (BF) will open. Opening the battery field contactor "cuts out" the main generator battery field excitation and causes the overriding solenoid (ORS) to move the load regulator toward the minimum field position. This action will generally correct the wheel slip, and it should not be necessary for the engineman to reduce the throttle. The function of the WSS relay is to recognize slow speed wheel slips and effect a slip correction with a minimum loss of tractive effort.

If further reduction of main generator excitation is necessary to correct wheel slip, the WS relay, actuated

by a current flow through the relay coil, picks up and opens both the battery and shunt field contactors, reducing the excitation of the main generator to a point where slipping stops. The time delay sanding valve (TDS) is energized, automatically applying sand to the rails. When the shunt field contactor opens, an additional resistance is added into the shunt field circuit resulting in a further but controlled unloading of the main generator. Opening the battery field contactor, energizes the ORS, and the load regulator moves toward the minimum field position. Thus, as soon as the slipping stops, the WS relay will drop out, and power will automatically be reapplied at a lower level than that at which the slipping was initiated. The application of power will then gradually return to that designated by the position of the throttle.

To correct high speed wheel slips with the traction motors connected in parallel or parallel shunt, either of the WS relays actuated by a current differential between traction motors 1 and 3 (WS 13) or 2 and 4 (WS 24) will pick up to reduce main generator excitation to a point where slipping stops.

Since sand is automatically applied to the rails during a wheel slip detection, it should be unnecessary for the engineman to operate the manual sanders. If continuous wheel slipping on sand occurs, the throttle should be reduced.

Battery Switch Panel
Fig. 5-10

511 Battery Switch

This switch, Fig. 5-10, is located in the electrical cabinet and connects the battery to the low voltage circuits. To start the Diesel en-

gine, and during normal locomotive operation, the main battery switch should be closed.

512 **Battery Ammeter** The battery ammeter, located on the rear cab wall panel, only shows whether the battery is charging or discharging. Normally the meter will indicate zero or a slight charge. If the ammeter shows a continual discharge, the auxiliary generator output should be checked or the battery may run down.

Fig. 5-11

513 **Reverse Current Relay** The reverse current relay, RCR, is shown in Fig. 5-11. The main purpose of the RCR is to prevent a reverse flow of current from the battery to the auxiliary generator. The reverse current relay opens the battery charging contactor whenever the auxiliary generator voltage drops below the battery voltage. This action prevents motorizing of the auxiliary generator by the battery.

514 **Battery Charging Contactor** (BC) The battery charging contactor is an electrically operated switch which connects the auxiliary generator output to the low voltage system. The reverse current relay controls the operation of the battery charging contactor.

515 **Ground Relay** Located in the cab side of the electrical cabinet is an electrical protective device called the ground relay, Fig. 5-12. The function of the ground relay is to automatically unload the main generator in case of a ground in the high voltage system. (A ground can be defined as current passing through the frame or carbody of the locomotive.)

If a ground in the high voltage system should occur, the ground relay will trip. When tripped, the ground relay opens the shunt and battery field contactors, unloading the main generator. The ground relay must be reset before the unit can again deliver power. The relay is reset by pressing in on the reset button on the relay. Should the relay repeatedly trip when power is applied, the power plant MUST be isolated.

Ground Relay
Fig. 5-12

CAUTION: Isolate unit before resetting the ground relay.

If a ground relay trips, the white needle in the relay will point to a red dot. In the normal or set position the needle points to the yellow dot in the relay.

With the ground relay tripped, the speed of the engine will be automatically reduced to Idle. If the ground relay tripped while the throttle was in the 5th or 6th notch, the engine would stop.

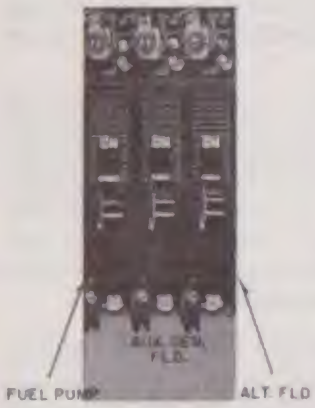
Although a high voltage ground will normally be the only reason for the ground relay tripping, a low voltage ground can trip the relay when the engine is started; since at that time the high and low voltage systems are temporarily connected. Ground relay action is not necessarily an indication of serious trouble but should be reported to the maintenance authorities.

The ground relay knife switch, when open, eliminates the protection of the ground relay. This switch MUST NOT BE OPENED in normal operation unless definite instructions are issued by an official of the railroad.

516 **Voltage Regulator** The voltage regulator, Fig. 5-13, is located in the electrical cabinet on the engineroom side. The voltage regulator performs the function of seeing that the output voltage of the auxiliary generator remains at approximately 74 volts whenever engine is running.

Voltage Regulator
Fig. 5-13

517 **Auxiliary Generator Fuse** (Battery Charging) This 150 ampere fuse (250 amperes if locomotive is equipped with steam generator), located in the electrical cabinet, Fig. 5-10, protects the auxiliary generator against any possible overload. If the auxiliary generator output fuse should become blown it will cut off the auxiliary generator from the low voltage system and alternating current system. The ammeter will indicate a discharge when the auxiliary generator output fuse is blown, the alarm bell will ring, and the "Alternator Failure" light (blue) will be ON in the unit affected.



Circuit Breakers
Electrical Cabinet
Fig. 5-14

518 **Auxiliary Generator Field Circuit Breaker** This 30-ampere circuit breaker located in the electrical cabinet, Fig. 5-14, protects the auxiliary generator field windings against excessive current. The "tripping" of this circuit breaker will prevent the auxiliary generator from supplying current to the low voltage system and the alternating current system. With the auxiliary generator

circuit breaker "tripped" the battery ammeter will indicate a discharge, the alarm bell will ring, and the "Alternator Failure" light (blue) will be ON in the unit affected.

519 **Alternator Field Circuit Breaker** This 30-ampere circuit breaker, located in electrical cabinet, Fig. 5-14, protects the alternator field windings against possible overload. The "tripping" of this circuit breaker will shut off the supply of AC current to the traction motor blowers and radiator cooling fans. When this circuit breaker trips open, the alarm bell will ring and the blue "Alternator Failure" light will be ON in the unit affected.

520 **No AC Voltage Relay** As the traction motors are cooled by AC driven blowers, failure of the alternator could result in damage to the traction motors unless the application of power was stopped. Thus, in case of an alternator failure, the NVR, Fig. 5-15, located in the cab side of the electrical cabinet, drops out and causes the alarm bell to ring in all units. The "Alternator Failure" light (blue) will be on, and the engine speed reduced to idle in the unit affected (if the throttle was in the 5th or 6th notch the engine would stop). The NVR "dropping out" can be caused by (1) "Auxiliary Generator Field" or "Alternator Field" circuit breaker tripped open (2) Auxiliary generator fuse blown or (3) Diesel engine stopped while "on the line."

NVR Relay
Fig. 5-15

SECTION 6

STEAM GENERATOR MODEL OK-4625

INTRODUCTION

The instructions contained in this section are for the guidance of personnel engaged in the operation of Model OK-4625 steam generators. A general description of the steam generator is given, the operating technique is outlined and a trouble shooting section is provided for the operator.

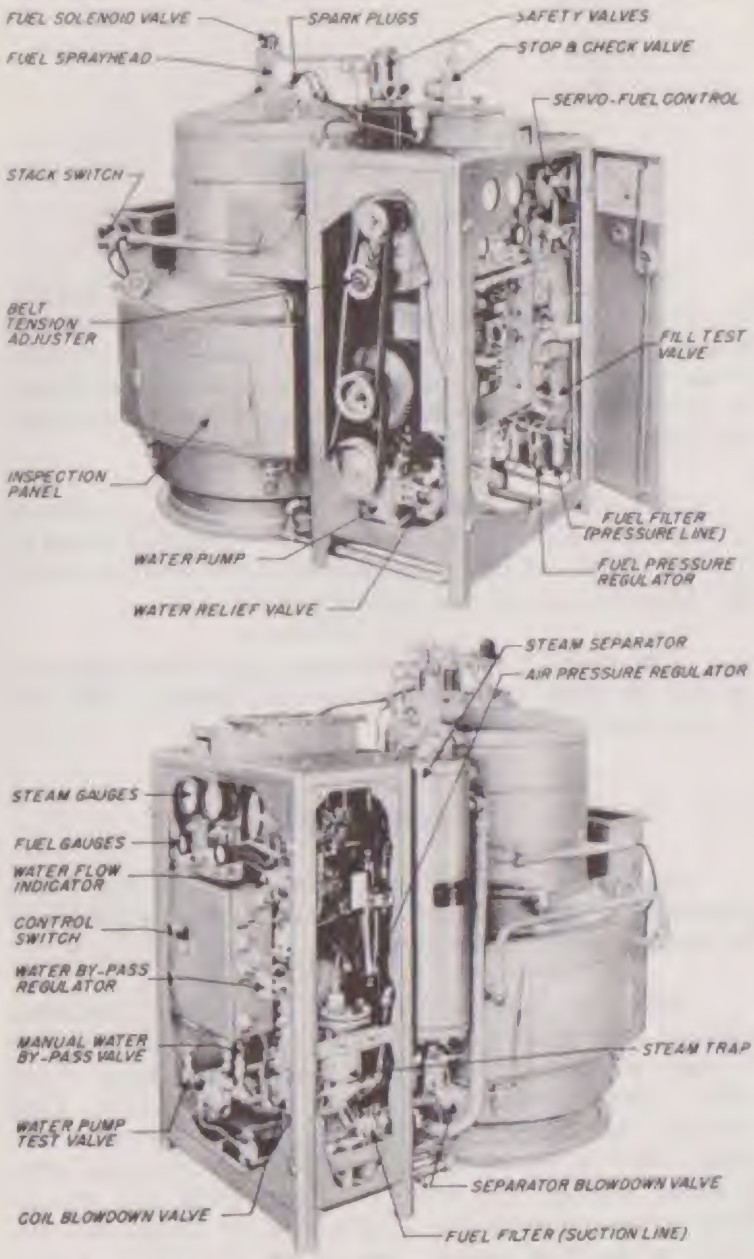
The symbol number after each device mentioned in the text refers to the schematic operating chart at the end of this section. The numbers are used to facilitate identification of the various devices.

The chart shows the various controls and devices on the OK-4625 steam generator and outlines the flow of fuel, water and steam.

DESCRIPTION

Operation is completely automatic after the steam generator is started, and full operating steam pressure is reached within a few minutes.

The steam generating part of the unit includes several sets of coiled water tubing, connected in series to form a single tube several hundred feet long. Feed water, after passing through the heat exchanger, goes through the economizer coil and from there to the main coils of the steam generator. As the water progresses through the coils it is converted into steam. Heat is furnished by the combustion of diesel fuel oil, which is sprayed by compressed air through the atom-



OK-4625 Vapor-Clarkson Steam Generator
Fig. 6-1

izing nozzle in the fuel spray head-105 into the firepot above the coils. Here the fine oil spray mixes with air supplied by the blower-202, and is ignited by a continuous electric spark-220. The hot gases flow, first downward, then up and outward through the coils, finally flowing out the stack.

The supply of fuel is regulated to evaporate approximately 90% of the water pumped through the coils. The excess water flushes scale and sludge from the coils and is carried over with the steam into the steam separator-221, where the water and sludge are separated from the steam.

The excess water collects in the bottom of the steam separator. Water above the level of the return outlet flows out through a steam trap-223 and through the heat exchanger-213, where it gives up its heat to the incoming feed water. From the heat exchanger the return water flows through return water flow indicator-218 back to the water supply tank-232.

The motor converter-215 drives the blower-202, water pump-230 and fuel pump-209 at a constant speed. The water by-pass regulator-111 automatically controls steam generator output by regulating the amount of water fed to the coils. Before entering the coils, the water passes through servo-fuel control-108, which admits fuel to the spray nozzle in direct proportion to the amount of water entering the coils. The servo-fuel control also adjusts the damper-203 to admit the proper amount of air for proper combustion of the fuel.

The trainline steam pressure is regulated by adjusting the setting of the water by-pass regulator-111. The length of train and the weather conditions determine the setting.

BEFORE STARTING

The valves designated by odd numbers must be OPEN during normal operation of the steam generator. Valves designated by even numbers must be CLOSED during normal operation of the steam generator. Normally open valves are fitted with a cross type handle; normally closed valves are fitted with the standard round handle.

Fig. 6-2

1. Make certain that the following valves are OPEN:

   Atomizing Air Shutoff Valve-1
   Coil Shutoff Valve-3
   Return Water Outlet Valve-9
   Trainline Cross-Over Valve-11
   Steam Admission Valve-13 to Water By-Pass Regulator-11
   Three-Way Washout Valve-17
   Water By-Pass Regulator Shutoff Valve-19
   Water Supply Stop Valve-21

Overload Reset
Fig. 6-3

2. Be sure that the following valves are CLOSED:

   Coil Blowdown Valve-2
   Layover Connection Shutoff Valve-6
   Manual Water By-Pass Valve-8
   Return Line Valve (Standby)-56
   Steam Admission Valve-10 to Radiation-217 (open in cold weather operation).
   Washout Inlet Valves-14-16
   Water Pump Test Valve-18
   Water Drain Valves-20 and 22

3. Both overload reset button-106 and stack switch-109 reset button must be "In." The overload reset button is located on the magnetic overload relay, Fig. 6-3.

TO FILL

1. Open the atomizing air shutoff valve-1 and fill-test valve-4; latch open the separator blowdown valve-12 to drain the steam separator. Close the separator blowdown valve when the separator is completely drained.

2. Close the main switch and turn the control switch-102 to FILL.

3. While the coils are filling see that spark-220 is available for ignition. Check ALL valves.

4. When water discharges from the fill-test valve-4 turn the control switch-102 to OFF and close the fill-test valve.

NOTE: If the coils are empty it will take about five minutes to fill the steam generator with water.

TO START

CAUTION: Do not start the steam generator unless the coils are filled.

1. Latch open the separator blowdown valve-12 and turn the control switch-102 to RUN. (For easy starting, be sure the control switch has been OFF long enough for the motor to come to a full stop.)

2. Close the separator blowdown valve-12 when the generator steam pressure gauge-212 registers approximately 150 pounds.

3. OPEN THE SEPARATOR BLOWDOWN VALVE SEVERAL TIMES FOR THREE TO FIVE SECOND INTERVALS DURING THE FIRST FEW MINUTES OF OPERATION.

Water By-Pass Regulator
Fig. 6-4

4. Set the water by-pass regulator-111, Fig. 6-4, to the required trainline pressure.

5. After the trainline is coupled, open the remote control trainline shutoff valve-7 (if used) by depressing the reset lever-7a. Then slowly open the trainline stop (shutoff) valve-15.

NOTES:

1. Check the return water flow indicator-218, Fig. 6-5, after the steam generator has settled down to a steady output. It should cycle from 4 to 12 times a minute.

2. If the steam generator does not start or function properly, check all valves to see that they are open or closed as indicated in the operation chart.

3. The steam generator should come up to full operating pressure in two or three minutes. It may take 10 to 15 minutes to build up the required operating steam pressure in the trainline, depending upon train length and the condition of the trainline.

Return Water
Flow Indicator
Fig. 6-5

STANDBY HEATING
(If Used)

Standby heating is applied to the locomotives to prevent freeze-up of the steam generator and its water supply tank at times when the steam generator is not required to make steam. In brief, the generator operates with an amount of fuel sufficient to heat the water but not to make steam, and circulates this hot water through the generator and supply tank.

When the control is switched to "Standby," the unit operates at low fire under control of an aquastat with full circulation of water through the coils, cycling "on" when the water temperature drops to 100° F., and cycling "off" at 135° F. During the "off" cycle the warm water is circulated through the system by a small circulating pump.

Low fire operation on "Standby" is obtained through the automatic burner adjusting control and the three-way solenoid valve. The burner control has a spring-loaded, hydraulic piston mechanism which controls the position of the metering pin in the servo. During normal operation, fuel pressure against this piston holds the metering pin up in its operating position.

On "Standby" the solenoid valve relieves the fuel pressure on the piston; spring tension then forces the piston down and holds the metering pin below its normal operating position, thus changing the delivery ratio of water to fuel and combustion air. Maximum water flow is maintained, but air and fuel flow into the combustion chamber is reduced to low-fire proportions.

Standby Operation:

1. Set the water by-pass regulator-111 for maximum pressure.
2. Close the stop-check valve-15.

Valves 56 and 15
Fig. 6-6

3. Close steam trainline pressure gauge line valve-11.

4. Open standby water return line valve-56 located at top of steam separator below stop-check valve-15, Fig. 6-6.

5. Open the radiation heating valve-10 and the layover connection shutoff valve-6 to allow the heated water to flow through the protective heating system.

6. Turn the Control switch-102 to "Standby" position.

Return To Normal Operation:

1. Close standby return line valve-56, radiation heating valve-10 (open in cold weather operation), and layover connection shutoff valve-6.
2. Open the separator foot valve and drain excess water from boiler coils, following the normal procedure for firing a boiler.
3. Place the control switch in "Run" position. When steam pressure reaches 150 psi, close separator foot valve, open stop-check valve-15.
4. Set water by-pass regulator at desired pressure.
5. Open steam trainline pressure gauge valve-11.

RUNNING ATTENTION

1. Open the separator blowdown valve-12 at least once every hour. (Except when in standby operation, if used). Frequent blowdowns will reduce the tendency for sludge to accumulate.

3. Turn the handle on the fuel filter-206, Fig. 6-7, during stops. At the same time, turn the handle on the treatment injector filter-225, where this method of water treatment is used.

Suction Line Fuel Filter
Fig. 6-7

CAUTION: Trainline remote control valve-7 (when used) and/or stop and check valve-15 must be closed when shutting off trainline steam.

TO SHUT DOWN THE STEAM GENERATOR

For short stops it is only necessary to close the stop and check valve-15. The fire will cycle and maintain operating pressure in the steam generator. For termical stop, proceed as follows:

Coil Blowdown Valve-2
Fig. 6-8

1. Close the stop and check valve-15 and the remote control trainline shutoff valve-7 (if used).

2. Set the water by-pass regulator-111 to maximum output. When the generator steam pressure gauge-212 registers 200 pounds turn the control switch-102 to OFF.

3. Open the coil blowdown valve-2, Fig. 6-8. When

the generator pressure drops to 75 pounds, close the valve.

4. Open the separator blowdown valve-12 and blow down the steam separator-221 with the remaining pressure.

5. Fill the coils with water according to the procedure given on Page 604, with the exception that it will be found advantageous to fill a "hot" steam generator with the separator blowdown valve latched open, thereby purging the coils while also eliminating the discharge of steam at the fill test valve.

6. Close the atomizing air shutoff valve-1 and open the main switch.

LAYOVER OPERATION

1. Open steam admission valve to radiation-10.

2. Open layover connection shutoff valve-6.

NOTE: When starting, do not omit draining the steam separator, opening the fill-test valve, and again filling the steam generator with water. If the coils are already full, it will only take a moment for water to discharge from the fill-test valve.

FREEZING WEATHER PRECAUTIONS

The inlet valve-10 to the radiation-217 should be opened when operating during severe weather.

If a locomotive consist does not have all of its steam generators in operation, open the layover connection shutoff valve-6, the trainline pressure gauge steam admission valve-11, and the inlet valve-10 to the radiation on idle steam generators. Be sure coil blowdown valve-2 and stop and check valve-15 are closed.

If a locomotive is left standing out of service, operate one of the steam generators or make a connection to the yard steam line.

If no steam at all is available, thoroughly drain the steam generator. Open the drain valves-20 and 22, the water pump test valve-18, the coil blowdown valve-2, the separator blowdown valve-12 and the coil shutoff valve-3. Break the pipe connections where necessary to completely drain the piping. Turn the water pump by hand to clear it of water, or blow it out with compressed air. Remove the cover of the water treatment or water strainer tank-234 and make sure it is drained.

TROUBLE SHOOTING

If one of the protective switches (magnetic overload relay, coil blowdown switch or stack switch) operates to shut down the steam generator, the alarm will ring and the GREEN "boiler off" signal will light.

Turn the control switch-102 to OFF and use the following instructions as a guide in locating the trouble.

Motor And Burner Shut Down During Operation

1. Blown fuses: The alarm will not ring and the instrument lights will go out. The main fuse (or circuit breaker) is generally located in the electrical cabinet of the locomotive. Check this fuse, and check the control fuses in the steam generator control cabinet. A test lamp and fuse clips wired inside the electrical cabinet may be used to check the fuses.

2. Overload reset button-106 "out." The alarm will ring; the instrument lights will remain on. Turn the control switch-102 OFF; check for hot blower-202

or water pump-230 bearings and for poorly adjusted pulley belts. Check the setting of the belt tension adjuster. Push the overload reset button "IN."

Stack Switch
Fig. 6-9

3. Stack switch-109, Fig. 6-9, reset button "OUT." Stack switch high temperature contacts are open. The alarm rings, instrument lights remain on. Turn control switch-102 to "OFF"; open the separator blowdown valve-12 and drain steam separator. Push in stack switch reset button. Open Fill-Test valve-4 and turn control switch to "FILL." When water discharges from Fill-Test valve, turn control switch to "OFF," close Fill-Test valve and start steam generator as usual.

4. Coil blowdown valve-2 partially open: The alarm rings, instrument lights remain on. Turn the control switch to OFF. Be sure that the coil blowdown valve handle is properly seated in the closed position, then start as usual.

5. Air switch-101 contacts open: The alarm sounds, instrument lights remain on. Turn control switch off. Be sure that the air admission valve-1 is fully open. Clean the strainer screen in the air line, and drain the air pressure regulator-100. If the low atomizing air pressure persists, increase the pressure by turning the regulator adjusting screw clockwise. When air pressure is restored, start as usual.

Motor Starts But Burner Does Not

If the fire fails to light the low temperature contacts on the stack switch-109 will not close and after a 45 second time delay the outfire relay will open the

circuit to shut down the steam generator. The alarm will ring and the instrument lights will remain on. Turn the control switch-102 OFF and check the following instructions for possible causes for the burner failure.

1. Ignition failure: Turn control switch to FILL - no spark visible through the peep hole glass, or spark is of low intensity. If an ignition fuse is blown or if the current flow is broken for any other reason, the ignition circuit will be inoperative. If the spark plug electrodes are dirty or too far apart or if the electrodes are too close together, the ignition circuit will not operate properly.

   Check the ignition fuses - use the test lamp and clips installed in the electrical cabinet for that purpose. Tighten loose cable connections and replace chafed or broken wire which may be breaking or grounding the circuit.

2. Low atomizing air pressure-201: The air switch-101 opens and breaks the circuit to the fuel solenoid valve-104, which then stops the flow of fuel to the sprayhead-105.

   Be sure the air admission valve is fully open. Clean the strainer screen in the atomizing air line and drain the atomizing air pressure regulator-100. If the low atomizing air pressure persists, tighten the adjusting screw at the top of the air pressure regulator to increase the atomizing pressure.

3. Low fuel manifold pressure-208: Turn the handle on the suction line fuel filter-206 several times. A slight suction leak may cause the manifold pressure to build up slowly; put the control switch-102 on FILL to bleed the fuel line and bring the manifold pressure up to normal.

4. Low fuel nozzle pressure-207: Lack of water causes the servo fuel control-108 to limit the supply of fuel entering the nozzle. (if the water supply is almost

completely stopped, the cam plate may come down far enough to actuate the cutout switch on the servo and close the fuel solenoid valve-104.)

Be sure that the pump belts have proper tension, the water pump test valve-18 is closed, the cover on the water treatment or strainer tank-234 is tight, the three-way washout valve-17 is fully open, and that the drain valves-20 and 22 are tightly closed.

Open and close the water by-pass regulator-111 adjusting handle several times to free the regulator from possible sediment. If the water pressure gauge-229 still registers low, close the water by-pass regulator shutoff valve-19. This closes the water by-pass line and permits all of the feed water to flow to the servo-fuel control-108; the steam generator will start at once if the by-pass regulator is causing the trouble. Set and manually regulate the trainline steam pressure by adjusting the manual water by-pass valve-8.

High feed water temperature or leaky water line connections may cause the water pump-230 to become air or vapor bound. Violent fluctuation of the water pressure gauge needle indicates this condition. Tighten leaky water line connections and bleed the line by opening the water pump test valve-18. Allow water to flow from this valve until no air or vapor bubbles are evident in the water.

Irregular Trainline Pressure

1. Burner cycles off and on: Insufficient water delivery causes the steam generator to run in superheat; the steam temperature limit control-110 operates to protect the coils against overheating. Check the water pump output as instructed in the preceding paragraphs.

2. Safety valves blow: Shut down the steam generator. Lower the trainline pressure setting on the adjusting handle of the water by-pass regulator-111 and start the steam generator again. If the safety valves-107 continue to pop, close the water by-pass regulator shutoff valve-19 and manually regulate the trainline steam pressure by opening and adjusting the manual water by-pass valve-8.

ITEMS TO REPORT

1. Water pressure greater than 100 pounds above normal.
2. Excessive stack temperature.
3. Fluctuation of the fuel manifold pressure.
4. Frequent cycling of the burner.
5. Water flow indicator not cycling.
6. Water by-pass regulator inoperative.
7. Any faulty operation of the steam generator.

STEAM GENERATOR OPERATION CHART
OK-4625

VALVES

Valves designated by odd numbers are fitted with cross type handles, and must be OPEN during normal operation of the steam generator; valves designated by even numbers are fitted with standard round handles, and must be CLOSED during normal operation of the steam generator. This applies only to the OK series steam generators.

CONTROLS

100. Atomizing Air Pressure Regulator
101. Atomizing Air Switch
102. Control Switch
103. Fuel Pressure Regulator
104. Fuel Solenoid Valve
105. Fuel Spray Head
106. Overload Reset Button Motor
107. Safety Valves
108. Servo-Fuel Control and Switch
109. Stack Switch
110. Steam Temperature Limit Control
111. Water By-Pass Regulator and Switch
112. Water Pressure Relief Valve
120. Aquastat (Standby)
121. Relief Valve (Standby)
122. Fuel By-Pass Solenoid Valve (Standby)

The following valves must be CLOSED during normal operation of the steam generator:

2. Coil Blowdown Valve and Switch
4. Fill-Test Valve
6. Layover Connection Shutoff Valve
8. Manual Water By-Pass Valve
10. Steam Admission Valve to Radiation (Open in cold weather)
12. Steam Separator Blowdown Valve
14. Washout Inlet Valve
16. Washout Inlet Valve
18. Water Pump Test Valve
20. Water Suction Drain Valve
22. Water Treatment Tank Drain Valve
56. Return Line Valve (Standby)

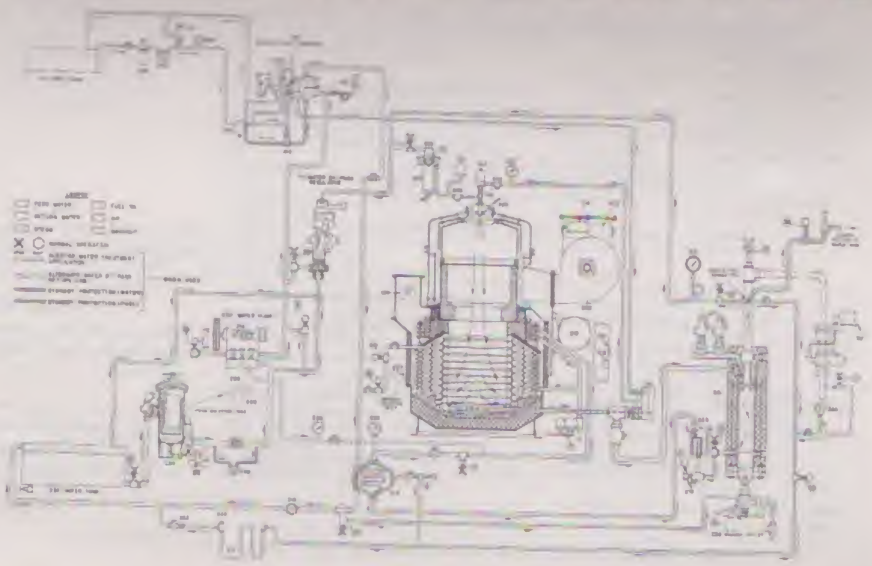
APPURTENANCES

200. Atomizing Air Strainer
201. Atomizing Air Pressure Gauge
202. Blower
203. Damper
204. Fuel Filter (Pressure line)
205. Fuel Filter (Suction line)
207. Fuel Nozzle Pressure Gauge
208. Fuel Pressure Gauge (At fuel pressure regulator)
209. Fuel Pump
210. Fuel Strainer
211. Fuel Tank
212. Generator Steam Pressure Gauge
213. Heat Exchanger
214. Ignition Transformer
215. Motor Converter
216. Oil Filter Cap
217. Radiation
218. Return Water Flow Indicator

The following valves must be OPEN during normal operation of the steam generator:

1. Atomizing Air Shutoff Valve
3. Coil Shutoff Valve
7. Remote Control Trainline Shutoff Valve
7a. Reset Lever
9. Return Water Outlet Valve
11. Steam Admission Valve to Trainline Pressure Gauge
13. Steam Admission Valve to Water By-Pass Regulator
15. Stop and Check Valve (Closed during start or shut down procedure)
17. Three-Way Washout Valve
19. Water By-Pass Regulator Shutoff Valve
21. Water Supply Stop Valve

218. Return Water Strainer
220. Spark Plugs
221. Steam Separator
222. Orifice Nipple (Radiation)
223. Steam Trap (Return water line)
224. Trainline Steam Pressure Gauge
225. Treatment Injector Filter
226. Treatment Injector Gauge
227. Washout Solution Inlet
228. Washout Solution Outlet
229. Water Pressure Gauge
230. Water Pump
232. Water Tank
233. Water Treatment Injector Pump
234. Water Treatment Tank (Strainer tank only if injector system is used)
235. Strainer Tee
240. Circulating Pump (Standby)



VAPOR HEATING OK-4625 STEAM GENERATOR TROUBLE SHOOTING CHART

Symptoms	Cause of Trouble	Remedy
Panel lights do not light; bell does not ring (Control switch "OFF" main boiler switch "ON")	Main battery switch "OPEN" - Fig. 22	Close
	Auxiliary generator switch "OPEN" - Fig. 22	Close
	100-150 amp. boiler fuse (2) for each steam gen. "Blown"	Test and replace
	15 amp. control fuse (2 on boiler panel) "Blown"	Test and replace
Motor does not run (control switch, Fig. 6, on "FILL," bell rings)	Stack switch tripped	Reset
	Motor overload tripped	Reset
	Coil blowdown valve-2 "OPEN"	Close
Motor runs, no strong flow of water from water pump test valve	Water tank empty	Fill
	Valve-21 on suction line closed (on line to treatment tank)	Open
	Drain valve-20 on suction line or treatment tank open	Close
	Top of treatment tank not tight	Reset and tighten
	Treatment tank strainer clogged	Clean
	Water in storage tank too hot	Make sure steam heat valve to water tank is closed

VAPOR HEATING OK-4625 STEAM GENERATOR TROUBLE SHOOTING CHART (CONT'D)

Symptoms	Cause of Trouble	Remedy
Motor runs, no spark at electrodes	Wires from electrodes to transformer broken or grounded	Repair
	Terminals loose on transformer	Tighten
	Gap between electrodes too wide	Reduce gap (should be 3/16")
	15 amp. ignition fuse (2 on boiler panel) "Blown."	Test and replace
Motor runs, fire does not light when switch is moved to "Run"	Atomizing air valve-1 closed	Open
	Motor not allowed to stop after filling, before turning boiler control switch, Fig. 6, to "Run"	Turn to "Fill" briefly, then to "Off." After motor has stopped and servo control is all the way down, turn to "Run."
	Electrodes not properly adjusted	Adjust. Report to maintenance.
	Nozzle not properly adjusted	Adjust. Report to maintenance.
Generator shuts off, bell rings	Stack switch tripped	Reset stack switch, refill coils, start steam generator, and set water by-pass regulator at next lower pressure. Report to maintenance.

VAPOR HEATING OK-4625 STEAM GENERATOR TROUBLE SHOOTING CHART (CONT'D)

Symptoms	Cause of Trouble	Remedy
Generator shuts off,	Motor overload relay trips, shutting down generator	Reset overload relay, refill coils and start steam generator. Report to maintenance.
Generator runs, dome gets hot	Lack of air, dirty coils	Set water by-pass regulator to next lower position. Report to maintenance.
Generator runs but no water returns through water flow indicator	Valve-9 in return line from separator closed	Open
	Return water strainer clogged	Clean
	Steam too dry	Report to maintenance.
Generator runs but generator and train-line pressure cannot be controlled by water by-pass regulator	Steam admission valve-13 closed	Open
	Water admission valve-3 closed	Open
	Defective water by-pass regulator	Close water shutoff valve-19 to water by-pass regulator, use manual by-pass valve-8 to control pressure. Report to maintenance.

LEGEND OF ELECTRICAL EQUIPMENT

The following list shows abbreviations identifying electrical equipment on the locomotive and/or the wiring diagrams. The diagram wire designations conform with the identification bands on the wires in the locomotive.

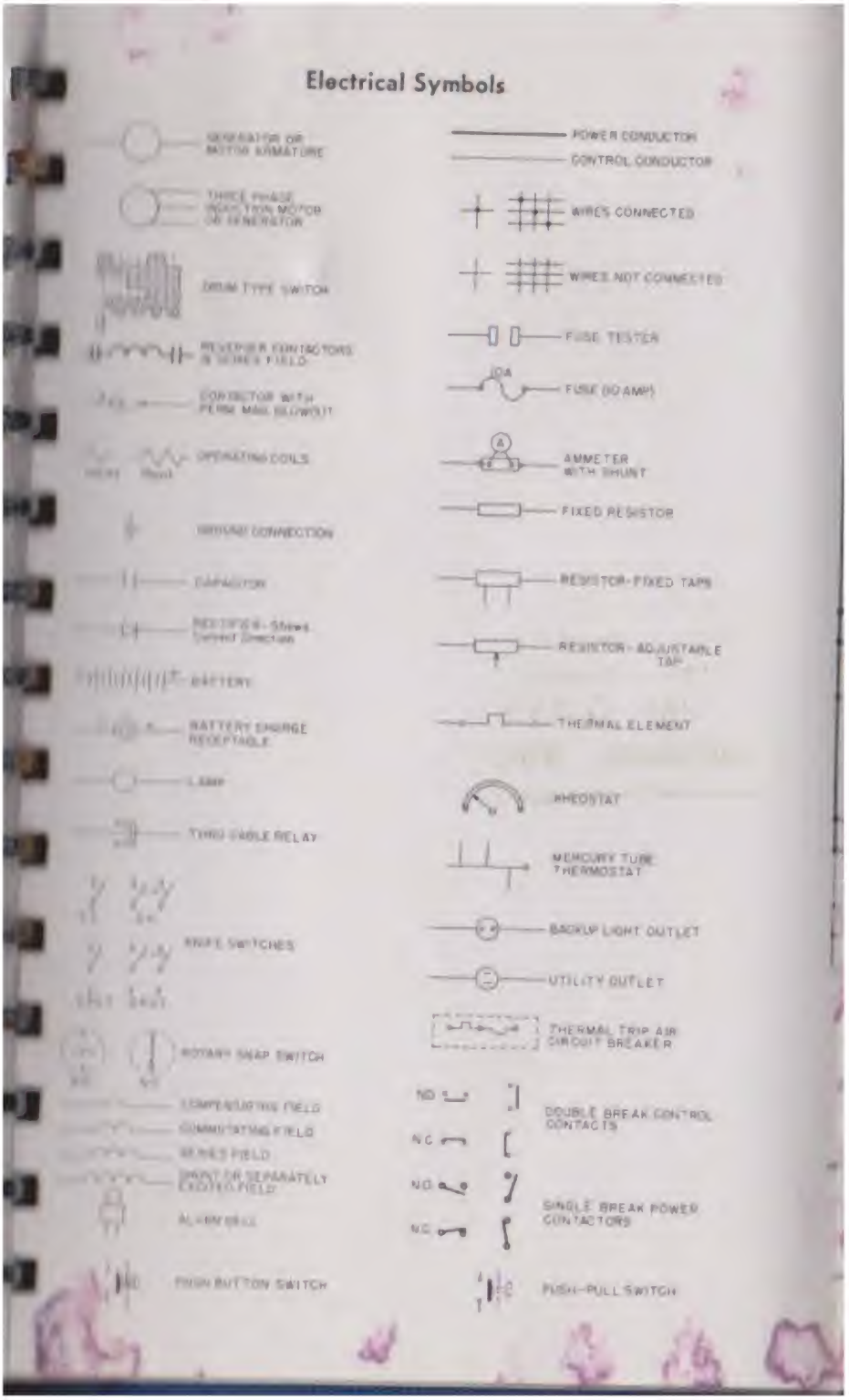
The diagram shows the contactors, switches and relays as if the engine was stopped and all manual switches open. It must be remembered that when the operating coil of a contactor becomes energized the contacts and interlocks associated with that contactor will then be in a position opposite to that shown in the wiring diagram.

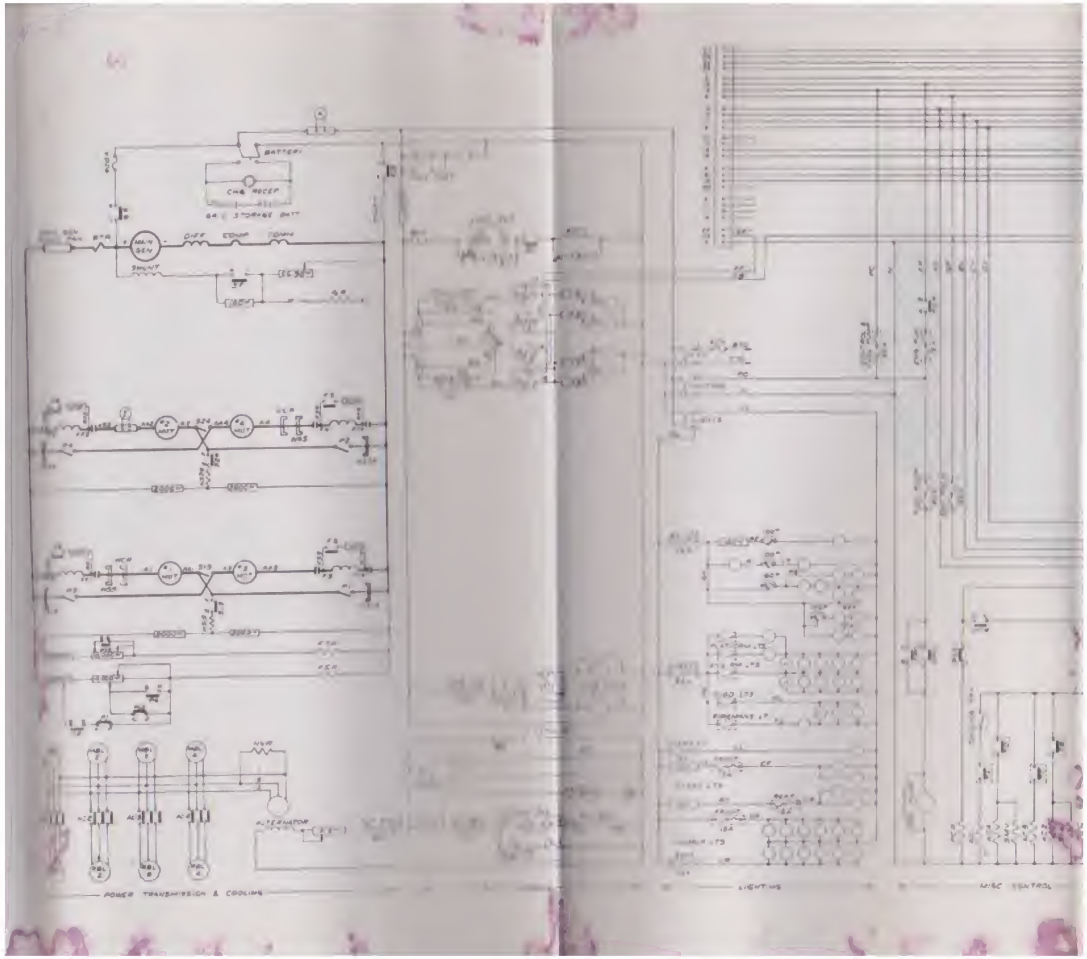
A	Ammeter (Battery Ammeter)
AC1,2,3,4	Radiator Cooling Fan Motor Contactors
AV,BV,CV,DV	Governor Control Solenoids
AWS	Auxiliary Wheel Slip Relay
BA	Boiler Alarm Light
BC	Battery Charging Contactor
BF	Battery Field Contactor
BKT	Dynamic Brake Transfer Switch
BKT-B	Dynamic Brake Transfer Magnet Valve - Brake
BKT-M	Dynamic Brake Transfer Magnet Valve - Motor
BR	Dynamic Brake Relay
BTR	Backward Transition Relay
BW	Brake Warning Indicating Light
BWR	Brake Warning Relay
C	Radiator Cooling Fan Motor Overload Switch
CC	Compressor Control Magnet Valve
CCS	Compressor Control Switch
CL	Class Light
CO	Traction Motor Lockout Switch
COMM	Commutating Field
COMP	Compensating Field
CR	Compressor Control Relay
DIFF	Differential Field

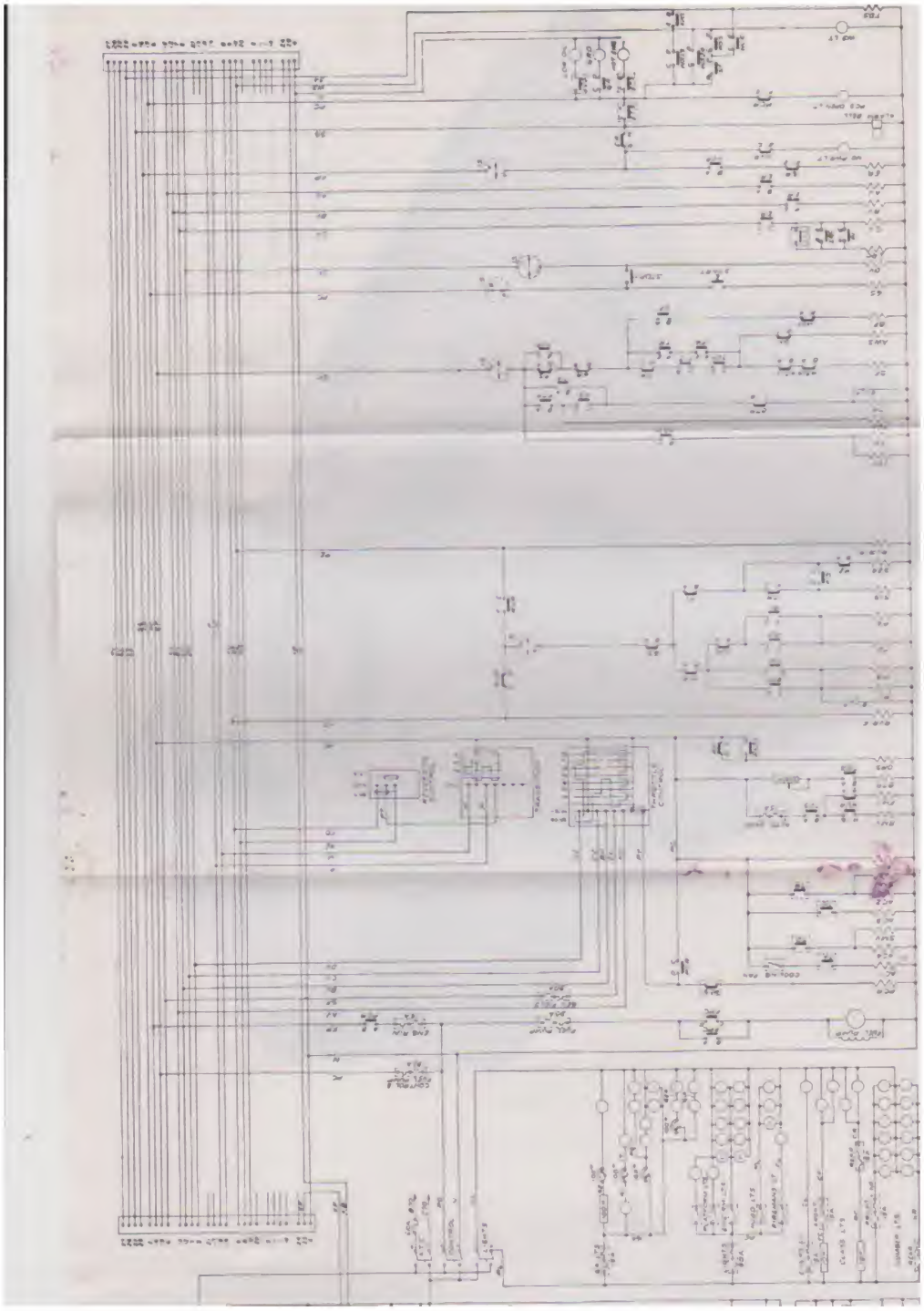
ER	Engine Relay (ER Relay)
ETS	Engine High Temperature Switch
FL	Field Loop Contactor
FMV or FSV	Forward Sanding Magnet Valve
FPC	Fuel Pump Contactor
FS	Traction Motor Field Shunting Contactor
FSD	Field Shunting Delay Relay
FSR	Field Shunting Relay
FTR	Forward Transition Relay
GA	Gauge Light or Switch
GF	Generator Field Contactor
GR	Ground Relay
GS± or ST±	Generator Starting Contactors
I	Dynamic Brake and Load Indicating Meter
IS	Isolation Switch
LOS	Low Oil Pressure Switch
LRC	Load Regulator Contactor
LRS	Load Regulator Contactor Switch (In Governor)
MBL	Traction Motor Blower Motor
NV	"Alternator Failure" or "No Power" Signal Light
NVR	"No AC Voltage" Relay
OLS	Governor Overload Switch
ORS	Governor Over-Riding Solenoid
OS	Low Oil Signal Light
P	Parallel Power Contactor
PCR	Pneumatic Control Relay
PCS	Pneumatic Control Switch
RBL	Radiator Cooling Fan Blower Motor
RCR	Reverse Current Relay
RMV or RSV	Reverse Sanding Magnet Valve
RVR	Reverser Switch
RVR-F or FOR	Forward Magnet Valve or Reverser Switch
RVR-R or REV	Reverse Magnet Valve or Reverser Switch
S	Series Power Contactor
SF or SH	Shunt Field Contactor
SFT	Shunt Field Transfer Relay

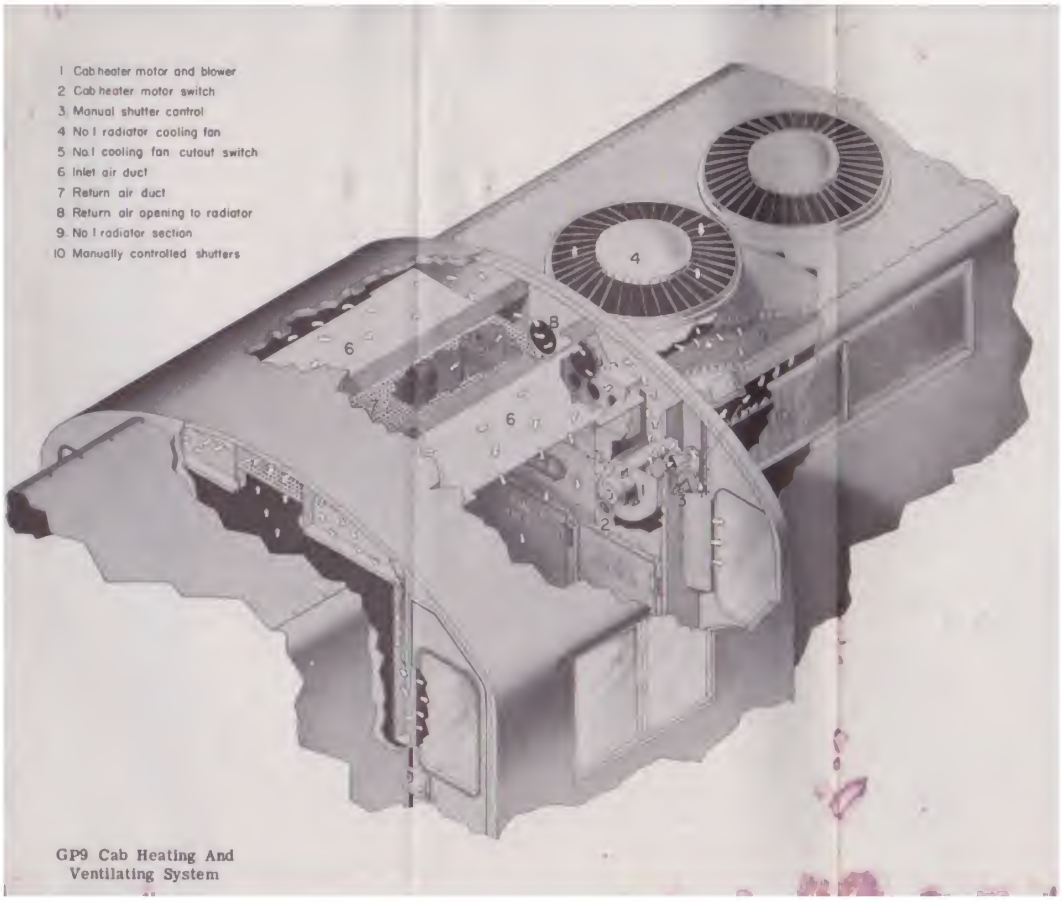
SMV	Shutter Magnet Valve
SR	Signal Relay
START	Starting Field
SWS	Summer-Winter Switch
TA-B-C-D	A-B-C and D Temperature Control Switches
TCR	Temperature Control Relay
TDB	Time Delay Backward
TDO	Time Delay Overload
TDR	Time Delay Relay
TDS	Time Delay Sanding Relay
TR	Transition Relay
TS	High Temperature (Hot engine) Signal Light
WCR	Wheel Creep Relay
WS	Wheel Slip Relay
WSA	Wheel Slip Auxiliary Relay
WSS	Wheel Slip Series Relay

Electrical Symbols




BATTERY
CHG RECEP
64 V STORAGE BATT
MAIN GEN
DIFF COMP
SHUNT
ALTERNATOR
POWER TRANSMISSION & COOLING
LIGHTING
MISC CONTROL





GP9 Cab Heating And Ventilating System